PETROLEUM REFINER

SPECIALIZED FOR THE OIL REFINING INDUSTRY, INCLUDING PETRO-CHEMICAL ENGINEERING, PETROLEUM SYNTHETICS AND NATURAL GASOLINE

December, 1944
Volume 23, No. 12

A Gulf Publishing Company Publication
EDITED MONTHLY AT HOUSTON, TEXAS

GRADY TRIPLETT
Editor

Copyright, 1944

CONTENTS

The Automatic Electric Timer in Refinery Processing 81
J. J. Loustaunau

Safety with Hydrofluoric Acid Alkylation 89
A. W. Trusty

Science in Natural Gas 92
James E. Pew and Frank H. Dotterweich

Viscosity of Propane-Oil Mixtures 101
R. W. Moulton and A. J. Mitchell, Jr.

Role of the Laboratory in Refinery Efficiency 105
John J. Stadtherr

Characteristics of the Differential Flow Type Meter and Conditions Affecting Its Operation—Part 3 108
L. K. Spink

Effect of the Diameter of Laboratory Columns with Fenske Packing on Their Efficiency and Capacity 113
B. A. Kazanski, A. L. Liberman and O. D. Sterligov

Pump Salvage Job 116
J. Barrie Graham

Application of Unit Operations to Fractionation and Other Vaporization Processes 118
R. L. Huntington

Textile Wetting and Foaming Agents from Petroleum 122
E. Proffit

Detergency or Dispersancy in Heavy Duty Engine Oils 124
Carl W. Georgi

Annual Index 129

Humble Celebrates Delivery of Billion Gallons of Aviation Gasoline by Refinery at Baytown 136

New Developments in Petroleum Research 144
J. K. Roberts

The Chemical Engineer in Petroleum Industry 149
George Granger Brown

Gulf Operating New 1000-Barrel Aviation Lubricants Plant at Port Arthur 159

Departments

Look Box 77

Science and Technology 194

New Equipment 270

Business Notes 276

Catalogs and Bulletins 285

Advertisers' Index 286

Petroleum Refiner is indexed by Industrial Arts Index.

CENSORSHIP NOTICE—Censorship rules occasionally make it necessary to tear out or otherwise delete parts of publications destined to subscribers outside the United States. If there be such deletions in copies of PETROLEUM REFINER going abroad, they are at the request of the Office of Censorship. Copies sent abroad face unavoidable delay because of time necessarily consumed in passing the publication through the Office of Censorship. —*The Publisher.*

SPECIALIZED OIL JOURNALS

Published by
THE GULF PUBLISHING COMPANY
OFFICE OF PUBLICATION
3301 Buffalo Drive, Houston, Texas

R. L. DUDLEY, *President*
A. L. BURNS, *General Manager*
J. KENT RIDLEY, *Managing Editor*
TOM W. NELSON, *Advertising Manager*

NEW YORK: Room 625, 250 Park Avenue, Dick Swinsky, Manager.

CLEVELAND: 1010 Euclid Avenue, C. L. Haskins, Manager.

CHICAGO: 332 S. Michigan Avenue, H. G. Fitzpatrick, Manager.

LOS ANGELES: 426 W. W. Wilson Building, Huntington Park, California, J. W. Curts, Manager.

TULSA: 1304 Hunt Building, J. F. Carter, Jr., Manager.

FT. WORTH: 203 W. T. Waggoner Building, H. H. King, Manager.

Single copies 35 cents (except special issues). Subscription price, domestic and foreign, $2.00 a year; 2 years $3.00. Entered as second class matter June 16, 1923, at the post office at Houston, Texas, under act of March 3, 1879. Advertising rates on application.

Copyrighted 1944 by The Gulf Publishing Company.

Masoneilan Displacement-Type

Provide Positive, Accurate Control of

- ***New type of control mechanism provides extreme sensitivity***
- ***Proportional Band adjustment with minimum upset of control setting***
- ***Wide range of standard sizes, 14 inches to 15 feet***

Have you a liquid level control problem that requires positive, accurate level control? Then investigate the new Masoneilan 12,000 Series Displacement-Type Level Controllers. Available in a wide choice of standard ranges from 14 inches to 15 feet, they give you unusual features not obtainable in any other types of controllers. A new type of control mechanism assures extreme sensitivity . . . a .001 of an inch change in level, changes the output pressure. Control action is always clearly indicated and the procedure to reverse the action is simple. Special stops protect the torque tube from mechanical overtravel. Case mounting can be reversed in the field from left to right without additional parts.

Solve your level control problems with the new Masoneilan Controller. They meet all your requirements for level control including interface service, gravity control and remote level indication. Write for complete information.

MASONEILAN

MASON-NEILAN

1182 Adams St.

New York Philadelphia Pittsburgh Tulsa Toledo Chicago Atla

VOLUME 23, NO. 12 DECEMBER, 1944

PETROLEUM
REFINER

SPECIALIZED FOR THE OIL REFINING INDUSTRY, INCLUDING PETRO-CHEMICAL ENGINEERING, PETROLEUM SYNTHETICS AND NATURAL GASOLINE
A GULF PUBLISHING COMPANY PUBLICATION

THE LOOK BOX

DECISION of the Senate Foreign Relations Committee not even to hold hearings on the Anglo-American oil agreement is the response to the resentment that followed signing of the agreement. The petroleum industry has vigorously opposed the treaty. Recently the public has shown its objection.

Not Even a Hearing

This death blow to an oil cartel, sponsored by government, is the first break in a policy toward oil that is difficult to understand. The administration has been profligate with the petroleum resources of this nation. It has exacted nothing in return. Currently the United States is the source of about 80 percent of petroleum requirements of the United Nations. The British have provided less than 10 percent.

There can be no doubt that the American petroleum industry both in this country and in South America had its reserves and its facilities in prime condition for a contribution to the war. It is fortunate that reserves existed and that facilities could be enlarged quickly.

But it is doubtful that this justifies a willingness to provide 80 percent of a total supply without even seeking recompense after the war is over. This has not been done. This whole proposition has been examined by Senator Owen Brewster, Republican, Maine, in the January American Magazine. He charges that funds advanced to Great Britain by the United States have enabled the British government to make a loan of $20,000,000 to Arabia.

Refusal to approve the oil agreement is encouraging for all of American industry.

ONE fifth of the families, now using coal for heat plan to shift to oil in the Philadelphia area. This was revealed in a survey by the Philadelphia Evening Bulletin, which classed it as a "serious economic dislocation to Pennsylvania's large anthricite area if it extends throughout the hard-coal-consuming territory."

Change To Oil

Evidently the convenience of oil as well as its cleanliness are factors too desirable to ignore without regard to cost.

It will be short sighted if efforts are made to thwart this trend. Laws could be passed under the guise of conservation to deny home owners the right of change. What is needed is an alert coal industry. Improvements are needed in coal handling equipment and the coal industry have been slow in providing them.

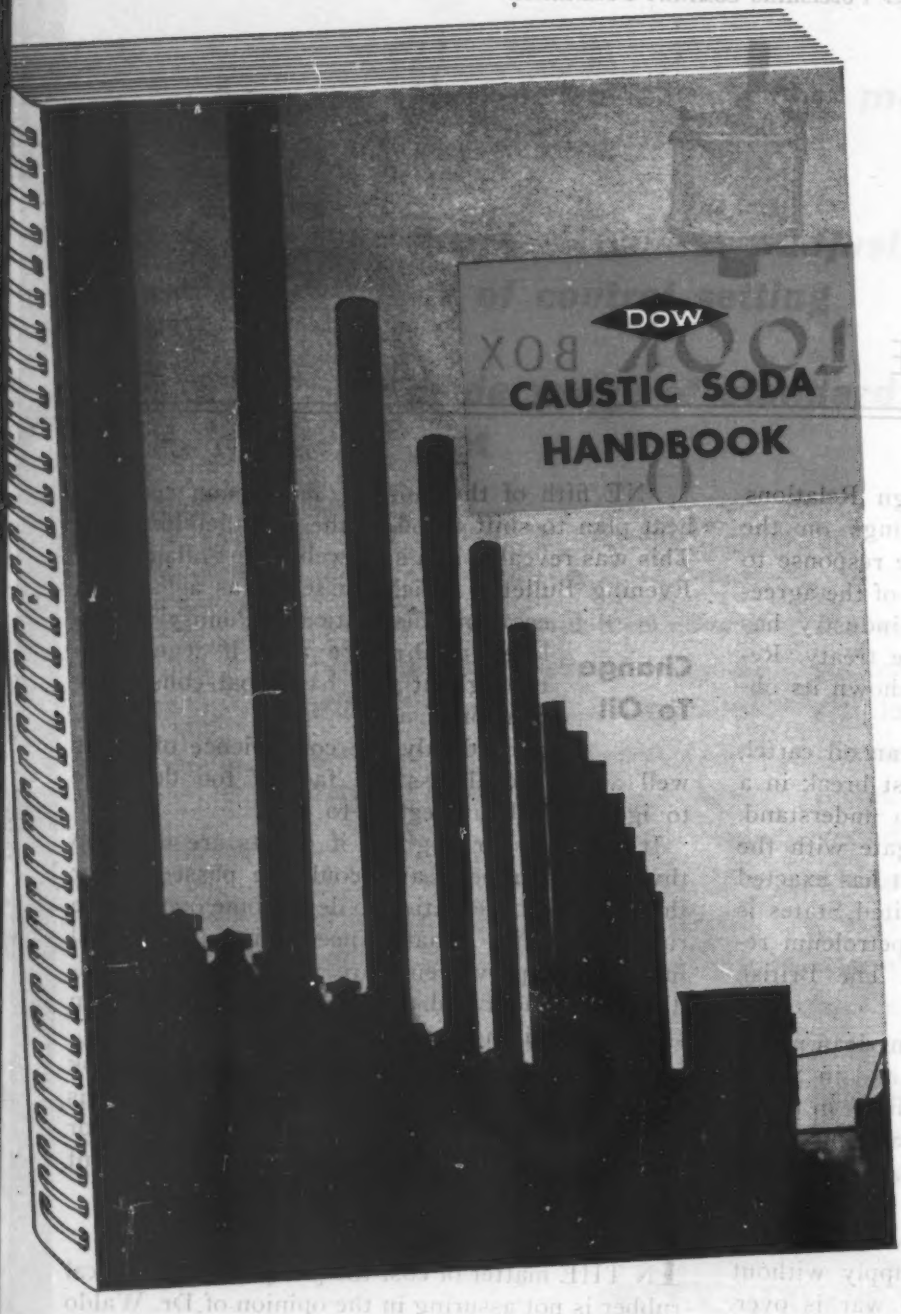
Both government and industry should look upon coal and oil as sources of energy. There is no doubt that coal can be converted into motor fuel. Each should be conserved by more efficient use.

IN THE matter of cost the prospect for chemical rubber is not assuring in the opinion of Dr. Waldo Semon, B. F. Goodrich Rubber Company technical director, who spoke before the National Industrial Chemical Conference in Chicago last month.

As to Cost

His estimate that synthetic rubber can be produced on a peacetime basis of 10.7 cents per pound was tempered by the admission that his calculation does not include amortization and profit. Along with it set forth

HOT OFF THE PRESS



complete new handbook on

CAUSTIC SODA

Traditional Dow services and product-quali
are now supplemented by an interesting ne
publication containing comprehensive per
nent information and technical data on Do
Caustic Soda. This book is available, witho
charge, to all users of this important produc
For your copy, write the nearest Dow Sale
Office:

Boston 16 . . . . . Statler Office Bld
Chicago 3 . . . . . Field Bld
Cleveland 13 . . . . . Terminal Tow
Detroit 2 . . . . . 932 Fisher Bld
Houston 2 . . . . . 2205 Commerce Bld
Los Angeles 14 . . . . . 634 S. Spring S
New York 20 . . . . . 30 Rockefeller Plaz
Philadelphia 2 . . . . . 1400 Penn Squar
San Francisco 4 . . . . . 310 Sansome Stree
Seattle 1 . . . . . 1702 Textile Tow
St. Louis 6 . . . . . 2nd & Madison Stree
Washington 5 . . . . . 915 Shoreham Bld

CAUSTIC SODA

THE DOW CHEMICAL COMPANY
MIDLAND, MICHIGAN

DOW

CHEMICALS INDISPENSABLE
TO INDUSTRY AND VICTORY

the fact that plantation rubber during the 1935-38 period could have been delivered into this country for 12.2 cents per pound.

The close margin of cost was offset by other considerations, which reveal steady progress in chemical rubber manufacture. Average cost of GR-S rubber thus far has been 34 cents per pound. But he paid this compliment to the industry:

"GR-S is better than the best German synthetic, Buna-S; easier to mix and handle, easier to build into finished products, gives better performance in service. Germany never was able to use more than 50 percent Buna in tires, whereas the S-3 tires on our cars today contain less than one percent natural rubber."

He predicted that future development will bring the use of several chemical rubbers into a single casing, a special product for coating cords, one for the sidewalls and another for the treads, with still a different product for inner tubes.

He recommended maintenance of at least 200,000 tons of annual chemical rubber capacity regardless of economics.

Octane Rating

IN ALL the speculation on postwar prospects scant attention has been given to the assurance of a high-octane motor fuel from the plants that are equipped with catalytic cracking units. Making a motor fuel of at least 80-octane rating will be a simple accomplishment in these units.

Indications are that not more than 100,000 barrels of 100-octane aviation fuel will be needed when hostilities cease. This will leave the base stock of at least 400,000 barrels of aviation fuel to be turned into ordinary motor fuel. In this use it will provide more than the 400,000 barrels of aviation fuel it replaces.

This prospect exists regardless of the need for ordinary motor fuel of 80-octane rating. As one man put it, "many of these plants can hardly make a fuel of octane rating lower than 80."

It will draw a sharp line within the industry. Immediately there will be a frantic effort to match this accomplishment in the present war-products plants. For the larger plants the accomplishment will involve only the spending of sufficient money to provide the catalytic unit.

But the smaller plants as yet have no wide selection of catalytic processes. Only two have been built on small scale requirements. All designers, however, are working to perfect the small plant compliment of the catalytic cracking unit.

That it will come is unquestioned. The hope is that available processes are offered in number sufficient to stimulate competition. It may be a few years before the automobiles of the nation need fuel of higher than 80-octane rating. But the refining industry will appreciate the assurance that the processes are ready ahead of actual need.

In Behalf Of Itself

IT IS encouraging to observe the efforts of industry to put research before the public in proper light. Research is an effort to make things at lower cost or of better quality; an effort to bring something new into existence; an effort to gain more profit.

For too long the research laboratory has been treated as a sacred precinct. Men and women who worked there were little less than shunned and looked upon as favored individuals. Fellow employes held an attitude of resentment and the public was indifferent.

In large measure this was the result of the attitude of executives. They sought to keep developments secret, which may be necessary. All too often they sought to maintain equipment and processes in service by withholding the developments of research.

That attitude is losing its standing. Research is coming into advertising copy so the public can understand what goes on when men set about to find a new or better method.

Successful research creates more jobs and that is an accomplishment well worth space in publications.

Super Safety

EARLY this year information became available to the effect that the Everett refining plant of Colonial Beacon Oil Company had a record of 685 days without a lost-time accident. The accomplishment was accepted as a result of a refreshing viewpoint in safety and Paul C. Shea, Colonial Beacon vice president, was invited to reveal the method.

By the time his article was printed in July the safety record had extended to 830 days. (Between receipt of the manuscript and its printing there was some fear of an accident spoiling a good story.)

But November 30 the plant personnel became recipient of a special award, made available by the board of governors of the National Safety Council, and the no-lost-time accident record stood at 1008 days.

Along with congratulations, here is a wish that the total is still climbing.

Devine
REFINERY EQUIPMENT

Fractionating Columns
Bubble Towers
Evaporators
Heat Exchangers
Condensers
Coking Drums
Tanks
Pressure Vessels
Kettles, Vats
Dryers
Special Equipment

DEVINE-BUILT TOWER

10 Ft. Dia. x 71'3"

The DEVINE plant is equipped to build vessels of any size to ASME or API-ASME code specifications.

Complete Engineering Service
Expert Fabrication

DEVINE offers years of experience in the oil refining field, *plus* the most up-to-date fabricating methods. DEVINE Engineers are prepared to design single units or complete layouts, or the equipment can be built from your own drawings and specifications in Devine's modern shops. In either case, you can be certain the completed job will meet the most exacting requirements. Let DEVINE Engineers figure on your next job.

J. P. Devine Division

H. K. PORTER COMPANY, Inc.
PITTSBURGH 22, PENNSYLVANIA

The Automatic Electric Timer In Refinery Processing

J. J. LOUSTAUNAU, E. B. Badger & Sons Company

THE electric process timer is in daily operation in many refining and chemical plants. Its development has been rapid and in step with the process developments. The designs described in this article have resulted from the combined efforts of the refinery and chemical-plant engineers, the consulting and design engineers and the process-timer manufacturers. All have made a substantial contribution to the development and application of process timers now in use. This work continues and each new application produces further improvements.

Each new project is subjected to a searching analysis with a view to increased reliability, reduced cost, and simplification in design, manufacture and operation.

The outlook for the future of electric process timing is encouraging. The rapid development of new products from petroleum, particularly in the related field of petroleum chemical projects, requires processes that depend to a great degree upon automatic control and automatic timing. With the background of experience developed in the petroleum-refining field, it is reasonable to expect that the electric process timer will continue to find new applications.

MANY advances and developments have been made during the past decade in petroleum refining and associated chemical industries. Some have been achieved in the orderly and methodical manner typical of progressive engineering application. Others have been more spectacular and to the average person, startling in their conception and accomplishment. The rapid growth of high-octane gasoline refining capacity and the development of synthetic-rubber production from little more than pilot plants to plants capable of producing more synthetic rubber than our prewar demand for natural rubber, are perhaps in this latter category. Those who have been engaged in the development, engineering and construction of projects of this nature have shared in a closely coordinated effort of all the branches of engineering. The metallurgists, the mechanical engineers, the electrical engineers, the structural engineers, to mention a few, have had the opportunity to contribute and assist in the complete development of projects initiated in the research laboratories, the pilot plants and full-scale plants of the chemical and petroleum engineers. The unique and specific requirements of the chemical and petroleum processes have given an impetus to the engineers in associated fields and have called forth not only the techniques and methods proven in other industries, but have required considerable ingenuity and originality in solving the problems presented.

The application of automatic electric timing to refinery and chemical processes is an outstanding example of a judicious and well-balanced mixture of techniques tested and proven in other industries, with engineering ingenuity and development of the highest order. Recent achievements in petroleum and chemical refining reflect credit upon this application. As the processes continue to develop in the search for new products and betterment in the refining of present products, it seems certain that new demands will be made of automatic electric timing. Processes now in the pilot-plant stage, it can already be seen will require this application in the full-plant scale. It is the intent of this article to describe the automatic electric timing installations in existing plants and to discuss briefly the features of a design that has proven successful.

Definition and Scope

The term "automatic electric timing" may be applied to a large number of devices; its meaning as limited to the scope of this article hence must be clarified. The ordinary electric clock is the most commonplace automatic electric timer. Practically all automatic electrical control equipment makes use of some form of electrical or electro-mechanical timing. Instrumentation in refinery and chemical processes is dependent to a large degree upon a mechanism which includes an electrically-operated timing device.

By definition, any device that will repeatedly complete a fixed number of operations or functions in the same sequence and in the same time interval may be classed as a timer. The device that depends on electric power for its source of energy and continuously repeats these operations at a fixed rate is an electric timer. The constant-speed electric motor meets these requirements and is found in the majority of electric timing devices.

The automatic-electric process timer which is the subject of this article does not differ in its fundamental design from any other electrically-operated timing device. It does differ in the manner in which its timing function is applied to achieve its major objective. This major objective is to control, by means of electric current, the operation of a large number of electrically-operated devices which regulate flow, pressure and temperature in the refining or chemical unit. The control of these devices in accordance with a predetermined time sequence which is developed from the process requirements is accomplished with a cycle timer by means of its electric timing device, a constant-speed electric motor, and a number of circuit-making and -breaking de-

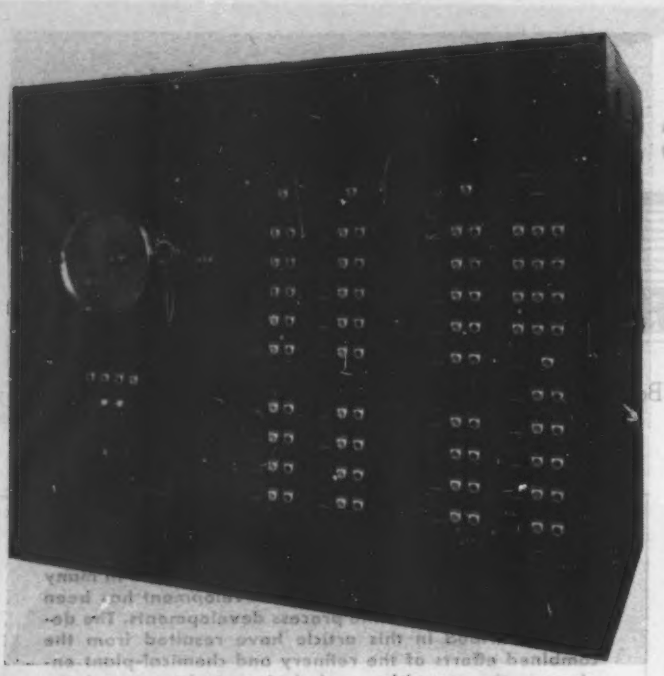


FIGURE 1

vices, mechanically operated from the motor. These devices are either a sliding contact, made by a moving contact surface slowly passing across a stationary contact surface, or a snap-action switch operated from a rotating cam. The fact that processes now in operation are using timers with 900 such contact devices indicates the magnitude and complexity of process timers.

The devices controlled by the flow of electric current from the timer may include motor-operated valves, solenoid valves, or any mechanism operated directly or indirectly by electric power. The sequence, duration and analysis of their operation may all, collectively or individually, be controlled by the timer. Operation of these devices in the refinery or chemical plant is actually the operation of the unit itself. The electric timer, therefore, is the master operator or controller of the unit in which it is installed. While manual operation, direct or indirect, of the timer-controlled devices is always possible, the automatic electric timer is indispensable to their continuous operation in the proper sequence.

A typical process timer is shown in Figure 1, which is the front view of a rotary type timer complete with push-button controls for the timer-operated devices. Figure 2 is the rear view of the timer dial, showing in more detail the actual contact-making arm and stationary contact pins. In this type of timer, the rotating arm which contains the moving contact surfaces rotates at constant speed, successively making contact with the stationary pins mounted in concentric circles. Since the arm moves at constant speed and the fixed pins are equally spaced, the time interval between each two contacts is the same. The term contact is used here to describe the actual touching of the moving and stationary contact surfaces. By connection of the control circuit of the devices controlled by the timer in series with these contacts, the sequence of operation of the timer-controlled devices can be established.

The left hand panel on Figure 1 contains the indicating dial with pointer attached to the rotating-arm shaft showing the exact position of the arm at any moment. The dial is numbered in accordance with the numbering of the stationary contacts shown in Figure 2. In addition, a counter is provided, which registers the actual number of the contact being made at any instant.

The rotary timer illustrated in Figures 1 and 2 is typical of one of several automatic electric process timers used in refinery processes. Others in use include the vertical timer and a rotary timer of recent design which contains two rotating arms.

The vertical timer has a contact arm moving vertically on a rotating vertical jack screw. The stationary contacts, small, flat, rectangular plates or segments, are mounted in parallel vertical columns, adjacent to the vertical jack screw. As the arm moves vertically on the rotating screw, spring-loaded brushes in this arm contact the stationary segments.

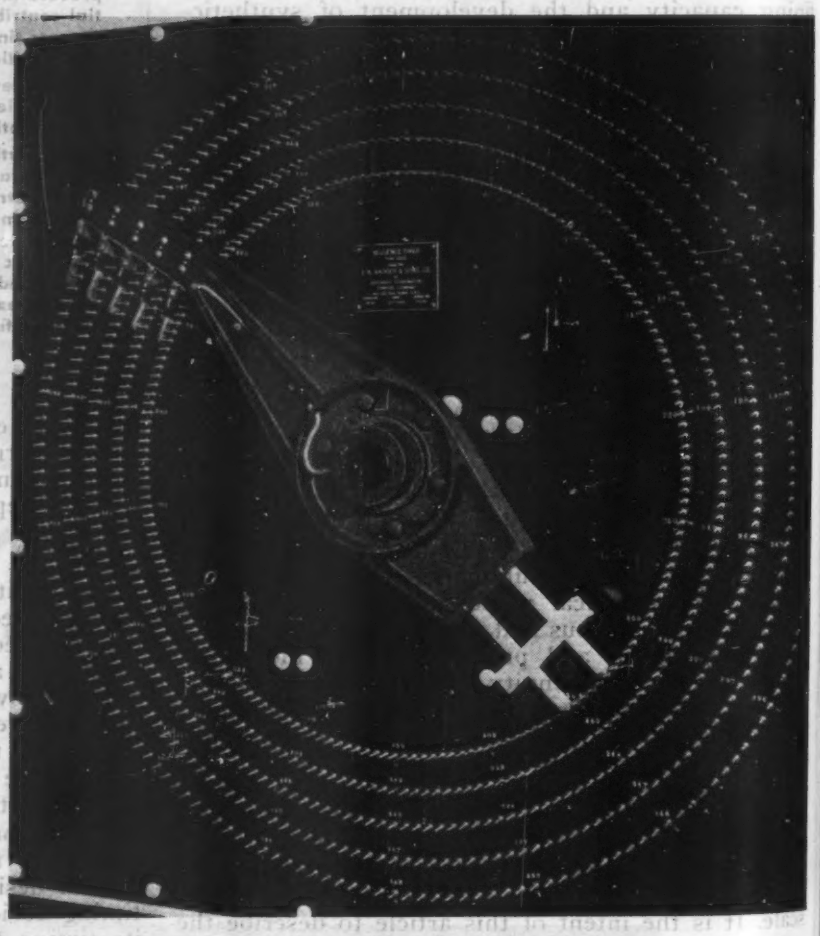


FIGURE 2

The rotary timer contains two rotating arms, each moving over a double row of flat rectangular plates or segments, mounted in concentric circles on an ebony asbestos panel. Spring-loaded brushes, mounted in the rotating arm make contact with the segments as the arms rotate. These circular rows are mounted directly one above the other and are enclosed by circular glass panels. This type and

the vertical timer occupy approximately the same panel space as the timer illustrated in Figure 1.

Functioning of the Automatic Process Timer

The most common method by which the automatic electric timer achieves its objective in process applications is by the closing of the control circuit in a magnetic motor starter. Since the control of flow invariably results in control of temperature or pressure, or both, the motor-operated valve finds wide use in timer-controlled processes. The typical motor-operated-valve application is controlled from a magnetic reversing motor starter. For non-automatic applications, the control circuit is connected to a pushbutton station. Pressing one button energizes the closing coil in the starter, closing one set of contacts, thus operating the motor in a direction to open the valve. Pressing the other push button energizes the second coil in the starter, closing the other set of contacts which operate the motor in the opposite direction to close the valve. In these applications, the sets of contacts are interlocked to prevent simultaneous operation. Control of the motor-operated valve from the process timer is accomplished by replacing the contact made by the pushbutton station with the contact made by the moving and stationary contact surfaces of the timer. Since most motor-operated valves are operated from 440-volt circuits, the motor starters used on timer-controlled valves are equipped with 110-volt control circuits. This is standard construction with motor-control manufacturers and does not involve special consideration. The use of 110 volts on the timer circuits naturally is preferable because of additional clearance and insulation required in the timer for higher voltages.

In a similar manner, solenoid-operated valves can be controlled from the timer. The solenoid valve may control flow in a small process line or it may function as a pilot valve on a diaphragm-operated control valve. Ordinarily such applications are made with a relay in the circuit between the timer and the solenoid to avoid the passage of relatively high currents through the timer contact surfaces.

Signal lights, alarm circuits, test circuits may also be operated from the timer. It follows that any function controlled or operated by the flow of electric current can be initiated or stopped by the timer.

Contacts

The contact between the moving and stationary contact surfaces of the timer exists for a very brief period, in the magnitude of a second, and it is necessary to provide "sealing" contacts on devices operated from the timer. This consists of an auxiliary contact in the device which is closed when the operating coil is energized and is connected in parallel with the timer contact. Thus the timer energizes the operating coil during the one second duration of the timer contact, causing the auxiliary contact to close and keep the coil-energizing circuit closed beyond the duration of the timer contact. Opening of the circuit is normally controlled by trip contacts in the controlled device.

Another method in use is the application of cam-operated switches. In this arrangement, the contact is made by either a mercury-tube switch or a small snap-action switch. As the cam rotates, it raises a metal finger attached to the switch, causing the switch to make or break the contact at the high point of the cam. The timing is determined by the speed and shape of the cam. This type of timing control has been used in several war plants. A single cam is used for each control point required and these cams are assembled on a shaft driven by a constant-speed motor. Figure 3 is a photograph of this type of process timer. The unit shown consists of two shafts, each with 41 four-inch-diameter cams, driven by constant-speed motors. A small cam-type master timer controlling the starting and stopping of the two shafts, is also included in this particular unit.

The cam-type timer finds application in processes requiring a smaller number of control points. The physical limitations are apparent when Figure 3 is compared to Figures 1 and 2. The rotary type provides 900 control points, compared to the 82 shown in Figure 3.

However, processes requiring several groups of control points with the points in each group operating in accordance with a fixed sequence, and the groups operated in a fixed time relation with respect to each other, provide a wide field of application for the cam-type timer. Where the interval between the groups is large and the operations in each group occur over a short interval, the use of relatively high cam speeds, the minimum speed being about 1 revolution in 10 minutes, together with a master timer starting and stopping the shafts, provides a satisfactory solution. Due to the mechanical features involved, the precision of the timing obtained with

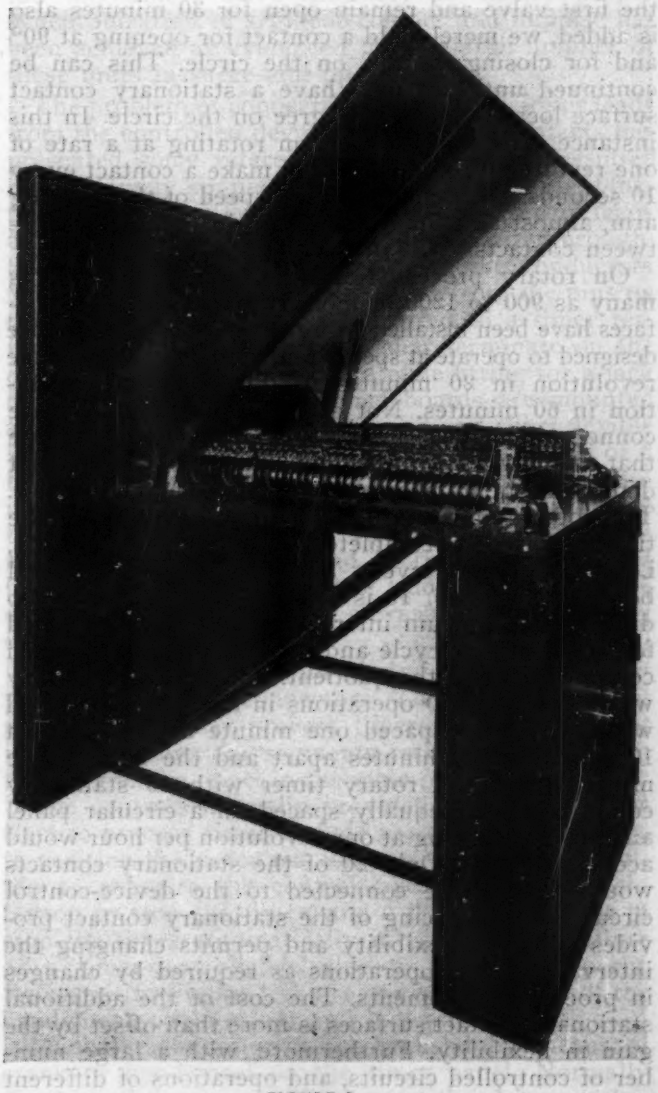


FIGURE 3

the cam-type timers is somewhat less than that obtainable with the types previously described.

A modification of the cam-type timer which employs air poppet valves to control the operation of diaphragm-operated valves has found process application. In this design the rotating cams raise or lower the poppet valve stems to increase or decrease the flow of operating air to the diaphragm valves.

The foregoing has described methods by which the straight control, i.e., starting or stopping, opening or closing, of mechanical devices in process units can be achieved by the process timer.

The automatic sequence control of the mechanical devices, which is control of the time interval between operations or of the duration of operation is the essential characteristic of the automatic electric timer.

This timing is achieved by controlling the rate at which the circuits are made or broken. For example, to open one valve for a half-hour period at the beginning of every hour would require a timer making contact to open on the hour and for closing on the half hour. A rotating type operating at a speed of one revolution per hour with two fixed contacts, one at the 0° mark on the circular panel and one at the 180° mark would suffice. The opening control circuit would be completed at the 0° contact and the closing circuit would be completed at the 180° contact. If an additional valve to open 15 minutes after the first valve and remain open for 30 minutes also is added, we merely add a contact for opening at 90° and for closing at 270° on the circle. This can be continued until we may have a stationary contact surface located at every degree on the circle. In this instance a timer with the arm rotating at a rate of one revolution per hour would make a contact every 10 seconds. By a change in the speed of the rotating arm, almost any time interval could be obtained between contacts.

On rotary process timers now in operation, as many as 900 to 1200 or more stationary contact surfaces have been installed with the rotary contact surface designed to operate at speeds ranging from one complete revolution in 20 minutes to one complete revolution in 60 minutes. Not all of the 900 contacts are connected to controlled devices. It is well to note that the number of controlled devices alone does not determine the number of stationary contact surfaces. The total number is actually determined from the time required to complete all the control contacts, i.e., total timing cycle, and the shortest interval between any two. It is normal design practice to divide the minimum interval into the time required for the complete cycle and install a number of fixed contacts equal to the quotient. For example, we may wish to control 20 operations in a 60-minute period with the first 5 spaced one minute apart, the next 10 spaced three minutes apart and the final 5, five minutes apart. A rotary timer with 60 stationary contact surfaces equally spaced on a circular panel and an arm rotating at one revolution per hour would accomplish this. Only 20 of the stationary contacts would actually be connected to the device-control circuit. Equal spacing of the stationary contact provides complete flexibility and permits changing the interval between operations as required by changes in process requirements. The cost of the additional stationary contact surfaces is more than offset by the gain in flexibility. Furthermore, with a large number of controlled circuits, and operations of different duration, it may be found that several operations should occur at one contact. This situation is undesirable since it will result in troublesome feedbacks, and it therefore becomes necessary to spread the operations over adjacent contacts. If the fixed interval between contacts is relatively small and contacts are equally spaced, the distribution is readily accomplished.

While the foregoing discussion has used the rotary type timer as an example, the same remarks apply to the vertical and other rotary types of process timers.

The timing element is introduced into the cam type timer in a somewhat different manner. The cams are mounted on a shaft which rotates at constant speed. The relative angular position of the cams on the shaft determines the timing sequence. This fact has an advantage in that the cams may be reset to any position on the shaft or adjustments made in their positioning to permit modifying the timing sequence. Also the shape of the cam itself can be made to determine the duration of the making or breaking of the contact.

Design

The description and functioning of the automatic electric timer have been presented without reference to the actual design details. There are certain specific requirements that must be met in any design of an automatic electric process timer. Since the instrument may be the master controller of a refining unit processing large volumes of charging stocks, careful attention and analysis must be given to its design.

The primary requisites include reliability, simplicity of design, ease of operation, and flexibility.

Reliability means that the instrument must operate with the highest degree of dependability and accuracy. It must be rugged and capable of performance equal to or better than that of the other electrical and mechanical devices in the unit. Its requirement in this respect is perhaps greater than that of many of the components within the unit for it is possible to install spare pumps, motors, etc., and to bypass other equipment to a limited extent in the event of mechanical failure. The electric timer, because of its complexity and cost, ordinarily is not provided with a spare, and failure of the timer results in a shutdown of the process unit.

Simplicity of design is naturally desired in any device which because of its nature is inherently complex. The cost of installation and operation can be held to a minimum only by elimination of all extraneous items and rigid adherence to fundamental circuits and essential functions. Freedom from maintenance problems is also a major advantage gained when the design is simplified.

The need for ease of operation is obvious. An automatic electric timer must be capable of operation by the average plant operators. The controls must be accessible, properly identified, and of a number consistent with minimum operating requirements, and must permit control or operation of the timer under all process operating conditions.

Flexibility is required because of the necessity for making changes in the sequence established by the timer in order to meet modified process requirements. In certain applications, variations in charging stock may make it necessary to change the duration of the complete time cycle or to change the duration of component parts of the cycle. The design must permit this with minimum effort and delay.

Fundamentally, the automatic electric process

timer consists of an electric motor, mechanical drive mechanism, contact-making devices, connection devices and terminal blocks, and timer control circuits and related devices.

The electric motor used in the typical process timer is a totally enclosed, self-cooled, single-phase synchronous type, 110-volt 60-cycle alternating-current motor. The motor rating is selected on the basis that normal output required is 50 percent of the motor full-load rating. Recommended practice has been to require two such motors installed on each timer with a manual shift lever to facilitate quick shifting from one motor to the other in the event of motor failure. The installation of two motors also permits alternating from one motor to the other at periodic intervals, thus reducing the continuous duty on each motor and decreasing the probability of motor failure.

The motor drives through a reduction gear to a gear train. The gear train is furnished with a set of change gears to provide the desired speed of rotation or travel of the moving contact. Sizes of gears are selected to give speed variations over the range required by the materials being processed in the unit. A mechanical arrangement which includes a shift lever is used to permit changing of gears without stopping the timer.

The motor normally is provided with a magnetic brake and a centrifugal switch. The purpose of the brake is to insure immediate stoppage of the motor upon loss of power. Protective relays, to be described later, will open the motor circuit upon failure of a timer-controlled device, such as a motor-operated valve, to function properly. Overtravel cannot be permitted since the operator must know the exact timer contact on which the failure occurred in order to take the necessary corrective measures. The magnetic brake connected in parallel with the motor winding, stops the motor instantly upon loss of power.

The motor centrifugal switch is a protective device which operates an annunciator circuit in the event the motor slows down appreciably or ceases to rotate. The annunciator, consisting of an alarm bell or horn and an indicating light, calls immediate attention of the operator to the fact that a motor failure has occurred.

Mechanical Drive Mechanism

The mechanical drive mechanism on the rotary-type timer consists of the change gears above described which drive the main gear attached to the shaft of the rotating arm. On the vertical type timer, the change gears drive a main gear on the vertical jack screw which, as it rotates, causes the moving arm to travel vertically. At the end of the vertical travel in either direction, a mechanically operated motor switch reverses rotation of the motor which in turn reverses the jack screw and direction of travel of the moving vertical arm.

The contact-making devices on the rotary type, illustrated in Figure 2, consist of stationary pins mounted in concentric circles on a bakelite or ebony asbestos panel. The moving arm carrying the same number of contact-making brushes as there are concentric circles, moves over these pins, making contact successively down a radial line of pins from the outer to the inner circle. The brushes are arranged to give a quick make. A slow break contact is permissible since the circuit is broken by an auxiliary contact in the controlled device. The material used for both the pins and the brushes is a copper alloy selected for its low electrical resistance and its wear-resistant qualities. The brushes are actually leaf-spring contact fingers. These are connected to a common wire and each makes contact with a pin for approximately one second. They are necessarily precision mounted so that only one contact is made at a time. The other types of contact-making timers use the flat plates or segments, either in vertical rows or concentric circles, for the stationary contacts and mount these segments on the ebony asbestos panel by means of small bolts terminating in a plug connector on the back of the panel. The material for these segments is an alloy selected for its low electrical resistance and its wearing qualities.

The moving contact consists of a number of cylindrical shaped brushes mounted in the movable arm. In addition, collector strips are installed alongside the segments and the circuit is completed from the segment through the brush and through the arm to the second brush on the collector strip. Normally, two brushes are installed to make contact with the plate and also with the collector strip. These brushes are spring loaded to insure positive contact. The diameter of the brushes is greater than the spacing between the segments, and an impulse switch, mechanically operated from the drive mechanism, is used to energize the circuit only when the brushes are passing over the center of each segment. Precision workmanship in mounting the segments and in the mechanical drive assembly to insure proper synchronization of segment contact and impulse has been achieved as evidenced by the large number of these units in successful operation.

The problem of connecting the control circuit leads from the controlled devices to the timer contacts has presented some interesting conditions and resulted in a relatively simple but effective design. The practice followed has been to terminate the control leads on a master terminal board equipped with through-threaded studs and nuts to receive the conductors from the control circuits. The leads from the pins on the rotary timer are likewise wired to a timer terminal board containing studs that terminate on the opposite side of the board in a male fitting for a jack connector. These two terminal boards are mounted adjacent to each other and one end of a short flexible lead is attached to the through stud by means of a terminal and nut. The other end of the lead terminates in a female fitting for attaching to the fitting on the timer terminal board. The installation is relatively simple since one end of the flexible lead is fastened to the proper control lead terminal and the other end is plugged to the corresponding stationary contact terminal.

Changes in sequence or timing are made by replugging the jack connectors. The same method is used on the other process timers described except that the rectangular segments terminate directly on the back of the panel in the male plug fitting.

The controls normally provided for an automatic electric process timer include a handwheel or crank to position the timer manually, a starting push button to energize the control circuits, a stop push-button to stop the timer, and a trip relay circuit to stop the timer automatically in the event of failure of a timer-controlled device to operate properly. Reference to Figure 1 shows one arrangement of the handwheel, pushbuttons and indicating lights.

Manual positioning is accomplishd by means of crank or handwheel on the timer panel. Normally disengaged, it can readily engage the drive mecha-

nism to permit moving the timer contact surfaces to the desired position.

For a further description of the timer control circuits and their functioning, reference should be made to Figure 4. This shows a typical timer control circuit which, with slight modifications, can be applied to the average automatic electric process timer application.

The devices shown in Figure 4 are identified as follows:

R = Manual relay coil
PB1 = Manual pushbutton
PB2 = Stop pushbutton
L_1 = Manual light
L_2 = Automatic light
PB3 = Automatic pushbutton
S = Automatic relay coil
M_1 = Timer Motor No. 1
M_2 = Timer Motor No. 2
MS = Motor electric switch
T & T′ = Trip relay coils
F1, F2, F3, etc. = Contacts in timer controlled devices which close on failure of device to operate properly.

The functioning of the control circuits is most readily understood by following the normal step-by-step procedure required to place the timer in automatic operation. The first step is the setting of the timer controlled devices. The opening or closing of the valves and setting of devices controlled by the timer must be done in accordance with some point of the operating sequence. The next step is to place the timer in the proper position corresponding to this point. After the timer has been manually positioned to correspond to the setting of the timer-controlled devices, the ready button is pressed, energizing the manual relay coil R. Contacts R1, R2, and R3 close, thus energizing the control bus A-B and illuminating the ready light. Since a momentary contact pushbutton is used, the R3 contact seals in the relay coil R.

The manual or "ready" operation serves a definite purpose. It permits the operator to energize the control bus and if necessary, permits operation of the electrical devices, motor-operated valves, solenoids, etc., by means of the manual pushbuttons provided for these items and located on a panel adjacent to the timer. Furthermore, it slightly lengthens the starting operation of the timer and permits the operator to make a final check of the equipment. The illumination of the manual light is evidence that the control circuit is energized.

Pressing of the automatic pushbutton, PB3, energizes the automatic relay S, closing contacts S_1, S_2 and S_3. Closing of contact S_1, seals in the relay. Closing S_2 starts the motor, and closing S_3 closes the circuit to the moving arm of the timer. Thus, pressing the automatic pushbutton PB3 starts the timer operating, illuminates the automatic light L_2, and as the control circuits are closed by contact of the moving and stationary surfaces, the devices controlled by the timer function in the proper sequence.

When the trip relays T or T′ are energized, the normally closed contacts T_1 and T_1' open and as reference to Figure 4 will show, their opening stops the timer motor. Two trip relays normally are used to avoid the possibility of failure of one to operate. The timer itself energizes the trip circuit as the following description shows. A timer-controlled device, such as a motor-operated valve, requires a definite time to complete its opening or closing travel. High-speed motor-operated valves will open or close in 9 to 10 seconds. To check the operation, a multi-contact switch operated by valve-stem travel is connected to the valve stem, either by a mechanical linkage or a gear train. One contact on this switch is set so that it is closed except when the valve is completely open, at which time it is open. This is called the open test contact. Another contact on this switch is set so that it is closed except when the valve is completely closed, at which time it is open. This is called the closed test contact. Each of these is connected directly to a stationary contact surface on the timer, which is contacted by the timer moving contact 12 to 14 seconds after the contact to open or close the valve has been made. For example, assume the stationary contacts are 2 seconds apart and contact No. 30 is connected to the opening circuit on valve No. 1. The open test contact for valve No. 1 would be connected to No. 36. If the valve failed to open completely in 12 seconds, the moving contact surface in touching No. 36 would complete the circuit through the open test contact on the multi-contact switch at the valve, through the coils T and T′, thus energizing the coils, and contacts T_1 and T_1' would

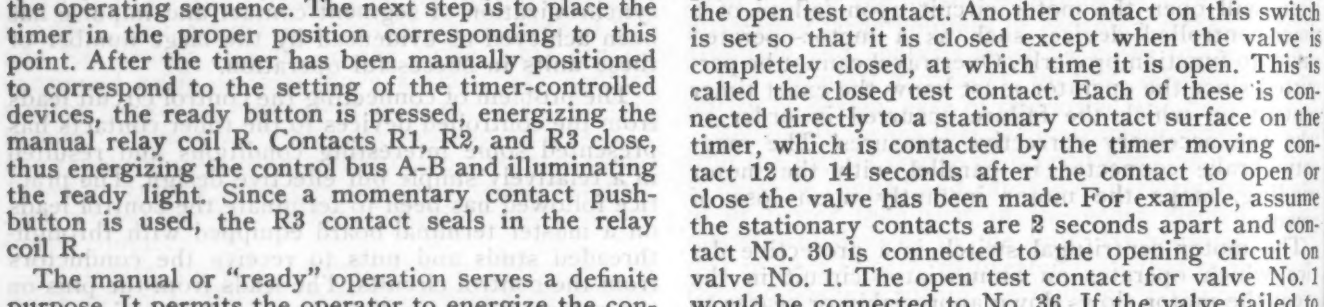


FIGURE 4
Timer control circuits

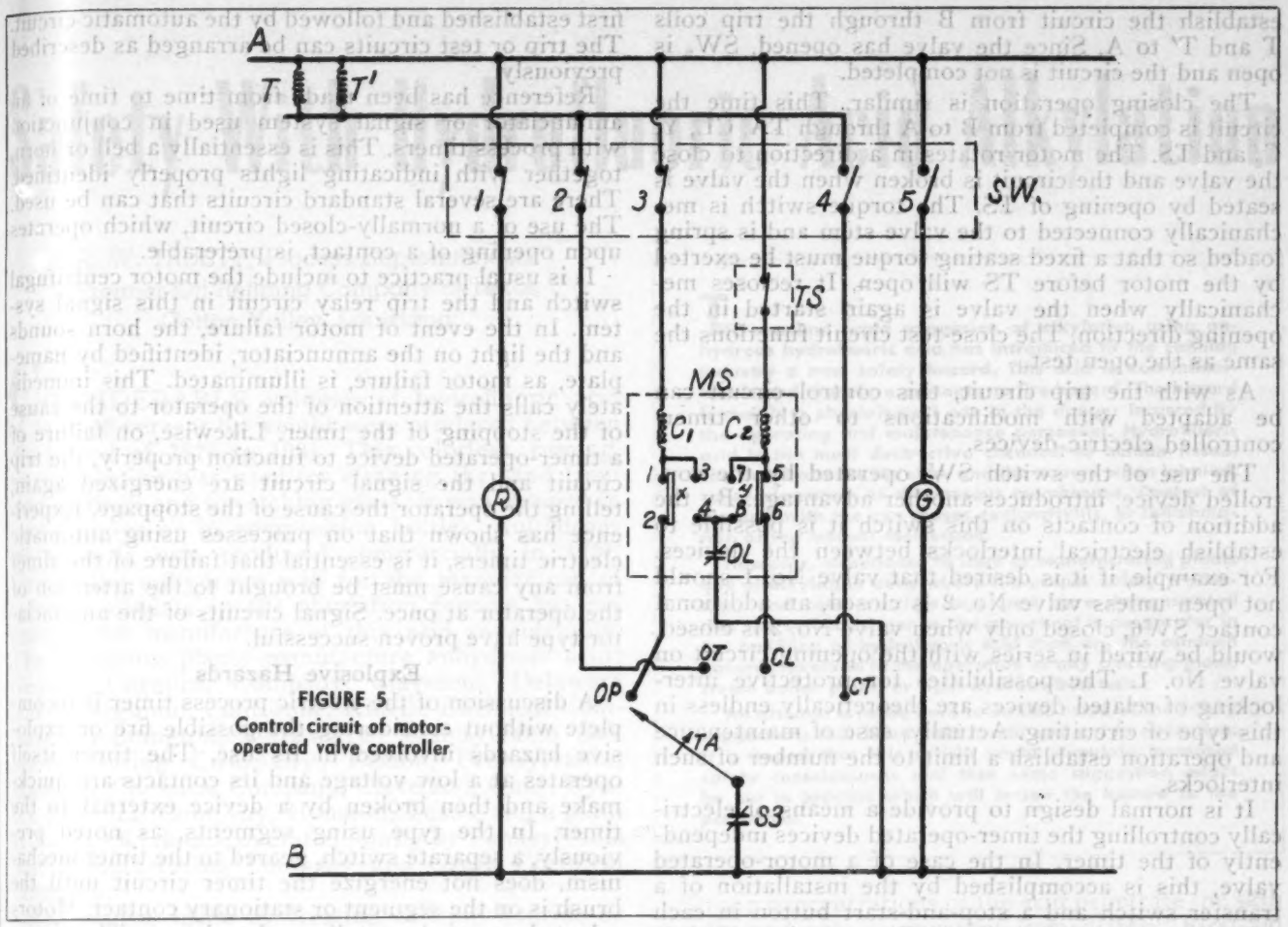


FIGURE 5
Control circuit of motor-operated valve controller

open. The F contacts in Figure 4 represent the open and close test contacts referred to above.

The timer would immediately stop and the operator, observing the position of the arm on timer dial would know that valve No. 1 had failed to open and would take the necessary corrective steps.

Figure 4 shows that when the test circuit is energized, the motor stops, and both the manual and automatic lights are extinguished. To restart the timer, the operator must first de-energize the trip relays by pressing the stop button PB2. The trouble causing the trip relays to operate must be corrected either before or after pressing the manual button. Then the automatic button may be pressed to restart the timer.

With slight modifications, the trip or test circuit can be applied to any timer-controlled device. Essentially, it requires a switch which is mechanically operated from the device and which is open only when the device has functioned properly. This switch, when connected in series with a stationary timer contact which is separated by a suitable time interval from the timer contact initiating the operation, will set up the test circuit. The time interval is determined from the time required by the device to complete its normal operation properly.

Further clarification of the control circuits associated with the timer is gained by reference to Figure 5. This figure shows the typical motor-operated valve-control circuits and the manner in which they are connected to the timer.

The circuit elements shown in Figure 5 are as follows:

T & T' — Trip relay coils—Refer to Figure 4.
SW — Multi-contact switch operated by valve motion.
TS — Torque switch—opens when valve seats.
MS — Valve motor controller—control circuit—Note that the line contacts in the motor circuit are not shown.
C_1 — Valve motor controller closing coil—When energized, closes line contacts to motor, so that motor rotates to open valve.
C_2 — Valve motor controller closing coil—When energized, closes line contacts to motor, so that motor rotates to close valve.
X — Auxiliary contact in control circuit. When C_1 is energized, X closes across 3 and 4, before breaking 1 and 2.
Y — Auxiliary contact in control circuit. When C_2 is energized, Y closes across 7 and 8, before breaking 5 and 6.
OL — Contact which opens when overload element in motor circuit overheats due to overload.
G & R — Valve position indicating lights. R is illuminated when valve is closed, G when open.
OP — Stationary timer contact for opening valve.
OT — Stationary timer contact for testing opening of valve.
CL — Stationary timer contact for closing valve.
CT — Stationary timer contact for testing closing of valve.
TA — Timer arm with moving contact surface.
S_3 — Contact in S relay—Refer to Figure 4.
A & B — 110-volt control power—Refer to Figure 4.

The circuit is shown in Figure 5 with the valve in the closed position. When the moving timer arm contacts OP, the circuit is completed from A to B through SW, C_1 and X. Energizing C_1, closes X across 3 and 4, opens 1 and 2, and closes the valve-motor controller line contacts so that the motor rotates in the direction to open the valve. As soon as 3 and 4 close, the circuit to B is held through OL. The motor continues to operate until the valve is completely open and SW_3 opens. This breaks the circuit from A to B and stops the motor. A brief interval later, 12 seconds on a 9- to 10-second valve, the moving timer arm contacts OT and attempts to

establish the circuit from B through the trip coils T and T′ to A. Since the valve has opened, SW_2 is open and the circuit is not completed.

The closing operation is similar. This time the circuit is completed from B to A through TA, CL, Y, C_2 and TS. The motor rotates in a direction to close the valve and the circuit is broken when the valve is seated by opening of TS. The torque switch is mechanically connected to the valve stem and is spring loaded so that a fixed seating torque must be exerted by the motor before TS will open. It recloses mechanically when the valve is again started in the opening direction. The close-test circuit functions the same as the open test.

As with the trip circuit, this control circuit can be adapted with modifications to other timer-controlled electric devices.

The use of the switch SW, operated by the controlled device, introduces another advantage. By the addition of contacts on this switch it is possible to establish electrical interlocks between the devices. For example, if it is desired that valve No. 1 should not open unless valve No. 2 is closed, an additional contact SW6, closed only when valve No. 2 is closed, would be wired in series with the opening circuit on valve No. 1. The possibilities for protective interlocking of related devices are theoretically endless in this type of circuiting. Actually, ease of maintenance and operation establish a limit to the number of such interlocks.

It is normal design to provide a means of electrically controlling the timer-operated devices independently of the timer. In the case of a motor-operated valve, this is accomplished by the installation of a transfer switch and a stop-and-start button in each motor-valve controller circuit. The transfer switch is a two-position switch which permits placing the valve control on automatic, i.e., timer control, or manual, i.e., pushbutton control.

The typical timer-control panel will thus consist of the timer dial in the case of the rotary timer of Figure 1, or the timer itself where the other types are used and an adjoining panel containing the transfer switches, pushbuttons and indicating lights for the controlled devices. Practice on refining plants has been to place these indicating lights in the relative position of the devices on a simplified process flow diagram painted either on the timer panel or above it. This permits the operator to gain a clear and complete picture of the functioning of the timer-operated devices at all times and reduces the possibility of errors in operation.

The description of the components of the automatic electric process timer and its function has been confined essentially to the rotary timer, since space does not permit a complete exposition of the variations and modifications in other types. However, with slight changes, the same description and circuiting can be applied to the other types, including the cam-type timer.

The motors and mechanical drives on the cam type are essentially the same as on the rotary within the limitations of the design. As stated previously, the cam timers usually contain a motor driving a master timer, which in turn energizes the individual timers, each with its own motor and gear train, in accordance with a predetermined sequence.

The contact-making devices differ but the method of terminating and use of terminal boards follows the rotary type. The control circuits of the timer itself are essentially the same. A manual or ready circuit is first established and followed by the automatic circuit. The trip or test circuits can be arranged as described previously.

Reference has been made from time to time of an annunciator or signal system used in conjunction with process timers. This is essentially a bell or horn, together with indicating lights properly identified. There are several standard circuits that can be used. The use of a normally-closed circuit, which operates upon opening of a contact, is preferable.

It is usual practice to include the motor centrifugal switch and the trip relay circuit in this signal system. In the event of motor failure, the horn sounds and the light on the annunciator, identified by nameplate, as motor failure, is illuminated. This immediately calls the attention of the operator to the cause of the stopping of the timer. Likewise, on failure of a timer-operated device to function properly, the trip circuit and the signal circuit are energized again, telling the operator the cause of the stoppage. Experience has shown that on processes using automatic electric timers, it is essential that failure of the timer from any cause must be brought to the attention of the operator at once. Signal circuits of the annunciator type have proven successful.

Explosive Hazards

A discussion of the electric process timer is incomplete without considering the possible fire or explosive hazards involved in its use. The timer itself operates at a low voltage and its contacts are quick-make and then broken by a device external to the timer. In the type using segments, as noted previously, a separate switch, geared to the timer mechanism, does not energize the timer circuit until the brush is on the segment or stationary contact. Motors selected are of the totally-enclosed type. The timers are located in control rooms which contain a large number of electrically-operated instruments and in all cases provision can be made for air conditioning the room or maintaining forced circulation of air. Since no lines carrying volatile liquids are brought into the control rooms, the degree of explosive hazard is slight. The type of construction described has been accepted as the most practical by refiners using electric process timers. The cost of making the timers shown in Figures 1 and 3 completely explosion-proof would be prohibitive. It is possible, however, to obtain an explosion-proof timer for processes where a high degree of hazard exists. Designs are available and it appears that applications of the electric process timer to petroleum chemical processes may employ explosion-proof timers. In instances of this nature, the cam-type timer whose function is to bleed air mechanically from a pilot valve can be used, requiring only that the motor driving the cam shaft and the necessary control switches and indicating lights be explosion-proof. Where several of the cam timers are controlled by a master timer, electrically operated, the master timer can be enclosed in an explosion-proof enclosure. It is possible that applications of this nature may be made in the future.

Acknowledgments

To the Automatic Temperature Control Company, Inc., for permission to use the photographs in this article. To Mr. W. E. Burpee of the author's associates, who has contributed much to the development of the circuits and design details described herein. To the above and to those who have given freely of their time and efforts in the preparation of this article, the author is indeed grateful.

Safety With Hydrofluoric Acid Alkylation

A. W. TRUSTY, Process Superintendent
Premier Oil Refining Company of Texas
Cotton Valley, Louisiana

THE wartime rapid expansion of alkylation using anhydrous hydrofluoric acid has introduced to the refining industry a new safety hazard. This acid is non-inflammable and therefore presents no fire hazard. The hazard is mainly a physiological one in the danger incurred by the operating and maintenance personnel. Hydrofluoric acid is the most destructive chemical to human tissue. The liquid attacks the skin, and the vapors when inhaled, cause ulceration of the mucous membranes. Contact of the acid with the eye causes conjunctivitis, or inflammation of the mucous membrane.

However, experience to date at manufacturing plants and at alkylation units where the proper safety precautions and safe practices are used have demonstrated that the actual danger to the personnel is no greater in the handling of hydrofluoric acid than are the common hazards involved in the operation of any cracking plant, steam boiler plant, or light-hydrocarbon unit.

An attempt is made here to outline some of the safety suggestions that have been made and put in operation. It is hoped that this article might stimulate increased safety consciousness and that some suggestion might be put in practice which will lessen the hazard to the personnel.

CONSIDERABLE volumes of hydrofluoric acid of 30 to 60 percent by weight were produced between the period of 1876 to 1931. This colorless, fuming, water solution was used for cleaning the sand from iron castings and for etching glass. It was shipped in lead carboys or in composition bottles. Anhydrous hydrofluoric was produced commercially in 1931. Use of the anhydrous acid for the manufacture of aviation alkylate in the alkylation process has expanded the manufacture of this acid considerably. The following plants manufacture anhydrous acid: General Chemical Company, Claymont, Delaware and El Segundo, California; Kinetic Chemical Company, Wilmington, Delaware; Pennsylvania Salt Manufacturing Company, Easton, Pennsylvania; Harshaw Chemical Company, Cleveland, Ohio; Nyatex Chemical Company, Houston, Texas, and a plant at Tulsa, Oklahoma, operated jointly by Pennsylvania Salt Manufacturing Company and Ozark Chemical Company.

The acid is made by treating calcium fluoride or fluorspar with sulfuric acid.

Properties

Anhydrous hydrofluoric acid has entirely different properties than that of the hydrofluoric acid solution. The specific gravity rises to a maximum of approximately 1.259 at 80 percent strength and then drops off as the strength increases. The physical properties of hydrofluoric compared with sulfuric acid are listed in Table 1.

The low freezing point permits it to be handled as a liquid under all commercial operating conditions. Its convenient boiling point near room temperature enables it to be handled as a gas or liquid. Its high fluidity and low surface tension enables the fluid to be easily pumped. Figure 1 shows the vapor pressure of anhydrous hydrofluoric acid.

TABLE 1
Properties of Anhydrous Hydrofluoric Acid[1]

	HF	H_2SO_4
Molecular weight	20	98.1
Freezing point	—117.4° F.	50.9° F.
Boiling point	66.9° F.	Decomposes
Heat of vaporization, Btu, per pound	543	326
Density	1.0 @ 32° F.	1.834 @ 68° F.

TABLE 2
Physical Properties for Commercial Strengths of Hydrofluoric Acid[1]

Strength of HF	30%	48%	52%	60%	80%	100%
Density, grams/cc @ 32° F.	1.119	1.188	1.205	1.235	1.259	1.0008
Density lbs./gal. @ 32° F.	9.339	9.914	10.056	10.307	10.507	8.350
Freezing point	—92° F.	—37	—31	—43	—148.5	—117
Boiling point	228° F.	223	214	185	111	67
Composition of vapor at boiling point in wt. percent	19	72	90	99	99+	100

Strong concentrations of the acid penetrate the skin rapidly and pain is apparent immediately. First-aid treatment should be administered at once since the acid is absorbed rapidly and continues to penetrate, destroying tissue as it goes, until the acid is neutralized.

In certain cases where contact is made with diluted acid, and particularly on the tough parts of the body such as the palm of the hand, where penetration of

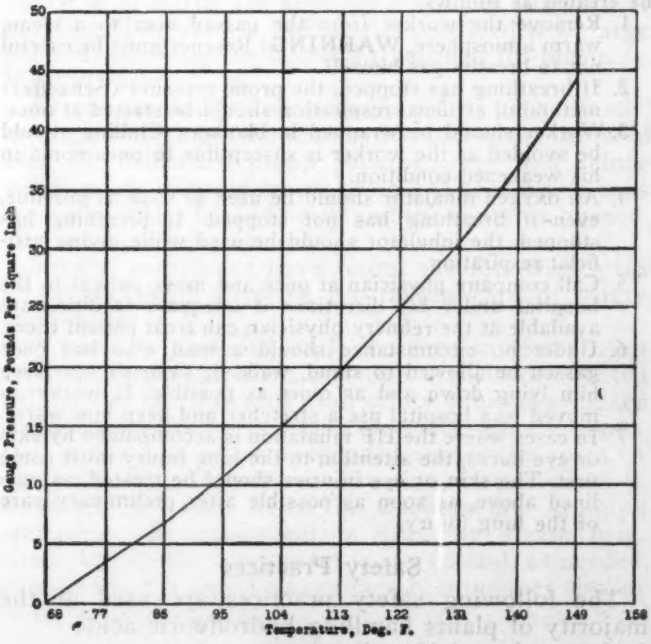


FIGURE 1
Vapor pressure of anhydrous hydrofluoric acid

the acid is relatively slow, pain may not develop for several hours. It is these "delayed-action" burns, where the fluorine penetrates the tissue, which are painful and require medical treatment.

In the case of burns with concentrated acid, or in the case of delayed-action burns, a subcutaneous injection of calcium-gluconate lactobionate is given by a physician or competent nurse. This injection forms a calcium barrier to neutralize the acid and stop the further penetration into the tissues.

Large signs indicating the first aid treatment should be placed in a conspicuous place in the first-aid room, shower rooms, and control rooms. The first-aid treatment as recommended by Universal Oil Products Company is as follows:

First Aid Treatment for Injuries from Hydrogen Fluoride (HF) Burns of the Skin

Burns from hydrogen fluoride may be divided into two classes:

1. Burns from high-concentration acid which are felt immediately.
2. Burns from low-concentration acid which may not be felt until hours after contact.

High-concentration acid burns should be treated at once as follows:

1. Wash the contacted area for at least 10 minutes with warm flowing water (about body temperature).
2. Daub the affected area with a cotton swab soaked in 3-percent ammonia.
3. Wash off the ammonia with water.
4. Rub magnesium-oxide glycerine paste (HF burn ointment) all over the burned area.
5. Report to the first-aid room.

The quicker this treatment is given the better the results will be. Work quickly but not frantically.

Low concentration acid burns:

In the case of low concentration acid burns, which may not be felt until hours after contact, wash with water, cover with HF burn paste and report promptly to your company doctor.

Eye Injuries

If HF gets in the eye it should be washed for at least 15 minutes in running water, and then normal saline solution should be applied.

The doctor should see all eye injury cases as early as possible.

Keep your eyes covered at all times while in the acid area to avoid all chance of getting HF in the eyes.

Inhalation

Inhalation of heavy concentrations of HF vapors should be treated as follows:

1. Remove the worker from the gassed area to a clean, warm atmosphere. **WARNING:** Rescuer must be careful not to breathe gas himself.
2. If breathing has stopped, the prone pressure (Schaeffer) method of artificial respiration should be started at once.
3. Worker should be wrapped in blankets. Chilling should be avoided as the worker is susceptible to pneumonia in his weakened condition.
4. An oxygen inhalator should be used as soon as possible, even if breathing has not stopped. If breathing has stopped, the inhalator should be used while giving artificial respiration.
5. Call company physician at once and move patient to the hospital under his direction: if adequate facilities are available at the refinery physician can treat patient there.
6. Under no circumstance should a man who has been gassed be allowed to stand, walk, or even sit up. Keep him lying down and as quiet as possible. If worker is moved to a hospital use a stretcher and keep him warm.
7. In cases where the HF inhalation is accompanied by skin or eye burns, the attention to the lung injury must come first. The skin or eye injuries should be treated, as outlined above, as soon as possible after preliminary care of the lung injury.

Safety Practices

The following safety practices are used at the majority of plants handling hydrofluoric acid:

1. *Instruction of New Employes.*

Each new employe is turned over to the safety director for the time necessary to point out the location of acid equipment, the location of restricted areas, instructions in first-aid treatment and in the hazards involved in hydrofluoric acid. Each employe is later given the Bureau of Mines first-aid training course, also instructions in the use of the oxygen inhalator. Thus each man is thoroughly acquainted with the properties and hazards of the acid, and with the location of hazardous areas.

2. *Instruction of Local Physicians.*

The medical treatment of hydrofluoric acid burns is a new problem to the majority of the medical profession. Pamphlets on the medical treatment of hydrofluoric acid prepared by the Universal Oil Products Company, for example, should be put in the hands of each local physician and hospital which might be called on for an emergency treatment.

It is also very important that the doctor be advised as to the nature of the chemical in cases of emergency treatment. For example, in a recent case a doctor treated hydrofluoric acid burns with mineral oil, not knowing that the burn was caused from hydrofluoric acid. The use of mineral oil was not the correct treatment and had the doctor been aware of the nature of the chemical, he would have used a water-soluble treatment. Oil-base salves or ointments usually make the conditions worse by keeping the acid in contact with the skin.

3. *Restricted Area.*

The hydrofluoric acid area should be marked as a restricted area by means of yellow lines around the concrete and by means of signs, "Acid Area, Do Not Enter Without a Permit." Before a maintenance worker enters the restricted area he must obtain a permit signed by the operator in charge of the area.

Permit to Enter Restricted Area.

Several companies are using the permit system and prohibit all workmen from entering the restricted area unless a written permit has been granted. The permit to enter is made out by the operator, area foreman or safety director, who at the same time checks the safety equipment required for the work to be done.

Water Hose Available.

A safety feature which has proven itself on a num-

IT IS the responsibility of the area operator or safety director, when issuing a permit to enter the acid area, to specify the type of safety equipment to be worn by the worker. The following classification generally is used:

Class A Clothing: Eye shield and neoprene gloves.

Class A Work: Visually checking operating equipment to observe pressures, temperatures, or flows. Maintenance work on any equipment that has been pumped out, flushed, vented, exhausted, and unheaded.

Class B Clothing: Helmet and face shield, neoprene gloves, neoprene apron.

Class B Work: Opening and closing valves. Removing packing from pumps or valves. Catching samples.

Class C Clothing: Neoprene gloves, neoprene shoes and overalls, face shield and cap. An air-fed acid hood should be used for work where there is a possibility of a sudden acid leak or acid spray.

Class C Work: Work on any equipment containing acid or acid-hydrocarbon, such as breaking into lines, opening vessels, opening or closing badly stuck valves, etc.

Class D Clothing: Full coverage suit (zoot suit) with outside air supply.

Class D Work: Opening or closing valves in the presence of acid leaks. Entering vessels that are not free of acid.

PERMIT TO ENTER HF ACID AREA

Date_____

Nature of Work_____

_____

_____

Safety Equipment Required:

Neoprene Gloves
Neoprene-soled Shoes
Rubbers
Boots
Rubber Overalls
Neoprene Coveralls
Rubber Coat
Face Shield
Hat
Acid Hood
Chemical Respirator
Dust Respirator
Goggles
Lamb Air Mover
Protective Coverall Suit
Stand By With Water Hose

Remarks_____

_____

_____

The Equipment to be Worked on Has Been:

Drained of Acid_____ (Check)
Flushed With Hydrocarbon_____
Exhausted_____
Exhauster Is Now On_____

Signed: (Operator in Charge of Acid Area)_____

Signed: (Person Obtaining Permit)_____

One copy is to be filed in Contactor Control Room.
One copy is to be kept by person obtaining permit.

FIGURE 2

ber of occasions is that of having available a water hose for all maintenance work. In case of an acid leak or in the case where acid comes in contact with a workman, water can be applied immediately to the worker or to the acid leak.

One plant has several sections of fire hose permanently connected to fire hydrants on two sides of the acid area. This fire hose is fitted with a fog nozzle so that in the event of a serious acid leak the fog water can be used to dissipate the acid fumes and at the same time keep the spilled acid diluted and washed away.

Bracing of Small Lines.

A number of the serious accidents have been caused by the giving away of small lines. It is general practice in several plants to backweld the threads on all small lines and also to brace all lines less than 1 inch in size with a brace placed in such a way that the strain from the thrust of the valve handles will be minimized. Also, it is considered good practice at some plants to install no acid lines of a size less than ¾-inch.

Operators and maintenance men are cautioned about opening valves on small lines and instructed to place themselves in such a position that in the event of a break the workmen will be able to step out of the way and avoid contact with the acid.

Neutralizing Medium for Acid Spills.

The base of the restricted area is covered with a layer of oyster shell or lime stone. The purpose of this material is to neutralize the acid in case of a dangerous spill. Several companies have found that the oyster shell tends to pack, thus preventing good drainage in the area. In some cases this oyster shell has been removed and the base paved with concrete. In this case an acid leak is neutralized with alkali from an overhead tank, or the acid is flushed away with a water stream from a fire hose.

Color Scheme for Process Lines.

The following color scheme or a similar series of colors for the various lines and valves in the process area is recommended; the use of such a color scheme helps the operators to avoid mistakes by using the wrong lines and valves:

1. Acid lines—yellow.
2. Hydrocarbon lines—purple.
3. Water lines—green.
4. Air lines—blue.
5. Exhauster lines—yellow with red stripes.

Neutralizing Vats

Neutralizing vats of approximately 10-gallon capacity are placed at strategic point in the acid area. These buckets contain about 5 percent sodium carbonate solution and it should be general practice of the operators when they leave the acid area to dip their rubber gloves in the alkaline solution and rinse in the water. A larger vat is provided for neutralization of all valves, meter parts, small lines and fittings before they are taken from the area for repair or other mechanical work.

Safety Showers.

Safety showers located in small buildings at convenient spots around the acid area provide a quick source of water in case of acid contact. The showers have a tank provided with a thermostat for providing a large volume of water at a temperature of approximately 80 to 90 degrees. It is important that the temperature be approximately that of the body because the use of cold water for prolonged washing of the body will give physical shock to the patient. The shower is operated by a floor treadle so that the victim steps on the treadle and is washed with a deluge of water. An alarm sounds when the showers are in operation. A red light is placed on the outside of the shower building and connected so that the light is on when the shower is in operation; thus an assistant will immediately know which shower is in operation and can render first aid to the patient. All first-aid supplies necessary for treatment of hydrofluoric acid burns are kept on a shelf in the shower building. The shower building is provided with large placards showing the first-aid treatment for burns.

Waste Drums.

Drums painted yellow with the words "HF Waste" in large letters on the drums are placed in the acid area for discarded pump packing, rags and refuse which might contain traces of acid. These waste cans are periodically hauled away and the contents burned.

Care of Safety Equipment.

Several companies have found the following plan to be the most effective for taking care of safety equipment:

A room is provided with the proper neutralizing and washing equipment and one man is designated to clean up and store all used safety equipment. Used equipment, such as neoprene overalls, gloves, hoods, etc., is hung on wires suspended across the room. A spray of water from three directions is turned on to wash off any acid. After the washing and draining operation, the equipment is dried by steam heat. After drying, the equipment is stored and, as needed, is issued to the maintenance men in a manner similar to the issuing of tools.

REFERENCE

[1] Harshaw Chemical Company Pamphlet, Anhydrous Hydrofluoric Acid, July, 1943.

Science in Natural Gas

JAMES E. PEW, Director, and FRANK H. DOTTERWEICH, Technical Consultant
Natural Gas and Natural Gasoline Division, Petroleum Administration for War

THE rise of our petroleum technologists to meet the present war demands for aviation fuel, synthetic rubber and explosives and other war products has sent them into all the scientific fields. No longer are they content with materials that will do the job well, but they constantly strive to improve the apparently perfect product, even duplicating in a period of minutes changes that nature required millions of years to bring about.

Man, once he had begun to get petroleum out of the earth, found that in many instances natural gas came ahead of it at terrific pressure. This was treated as a nuisance or hindrance, or at best as a thing of uncertain and local economic value. Although the value of natural gas as a fuel was always recognized, long before the advent of modern natural-gas practices and even at the present time, enormous volumes have been blown to the air, burned and lost. Today finds not only modern technologic procedures allowing for the development and perfection of means of discovery, production, transportation and storage of natural gaseous hydrocarbons, but also the magic hand of science is now converting this increasingly valuable natural resource into newer and super forms of energy and into varied chemical ingredients from which may be derived amazing products—products that will allow us to be victorious and to continue in our way of life with better health and greater happiness. Thus, natural gas, once looked upon with scorn, avoided and intentionally wasted, now takes its place beside its twin, petroleum, in comparative value. In this paper, the authors will endeavor to direct major attention to science in natural gas; what has been accomplished during the present emergency, together with what may come about in the period to follow.

The scientist of the petroleum industry seems to be the forgotten man in the current public discussion on how long our petroleum reserves will be sufficient to meet the increasing demands for fuel and other useful products before we must turn to substitute sources. While such discussions are in progress, the petroleum technologist is writing his name in the scientific hall of fame by bringing about many advances in refining technique, chief of which is the

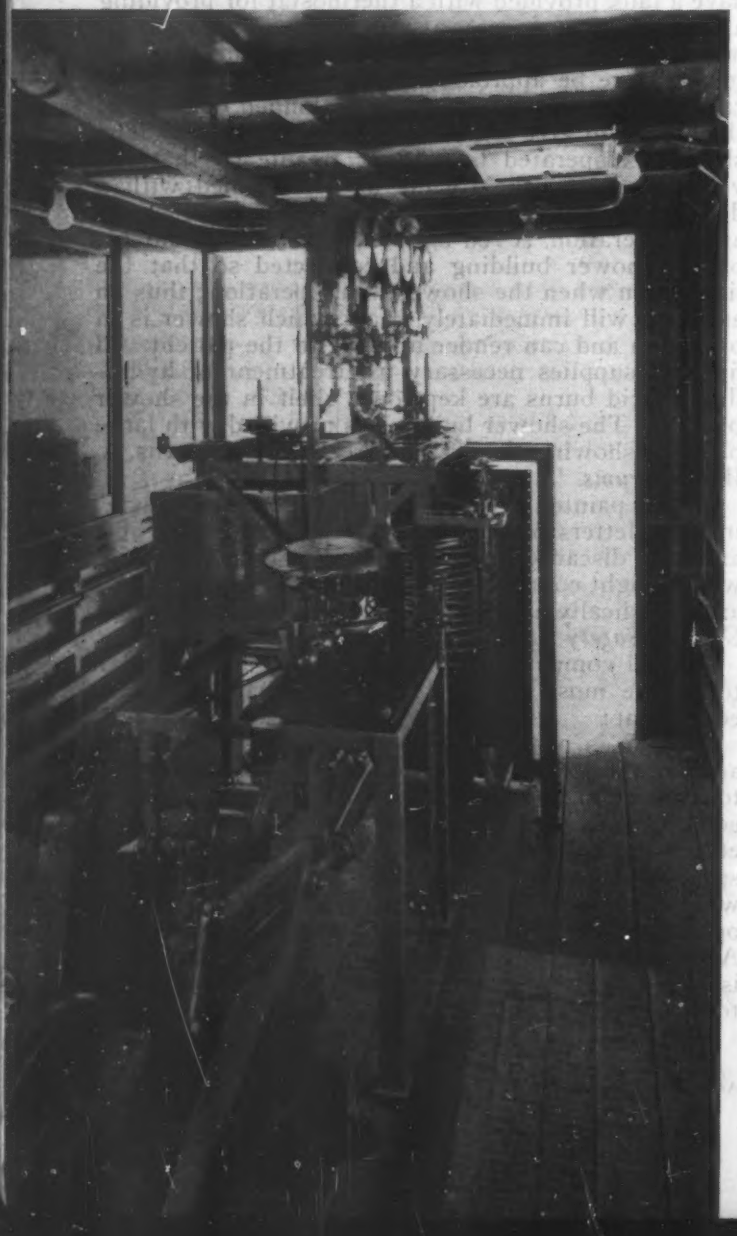
RESTRICTIONS of military necessity are a handicap in writing on a subject as active as processing natural gas. It simply would not be wise to publish all the facts. The authors of this paper have given due consideration to that handicap but they will have some encouraging observations.

Natural gas has become something besides a convenient fuel. Already a carbon chain is being made from carbon black and this chain will permit making a synthetic rubber which will conduct electricity. Thus the dread of ice formation on airplane wings will be forgotten.

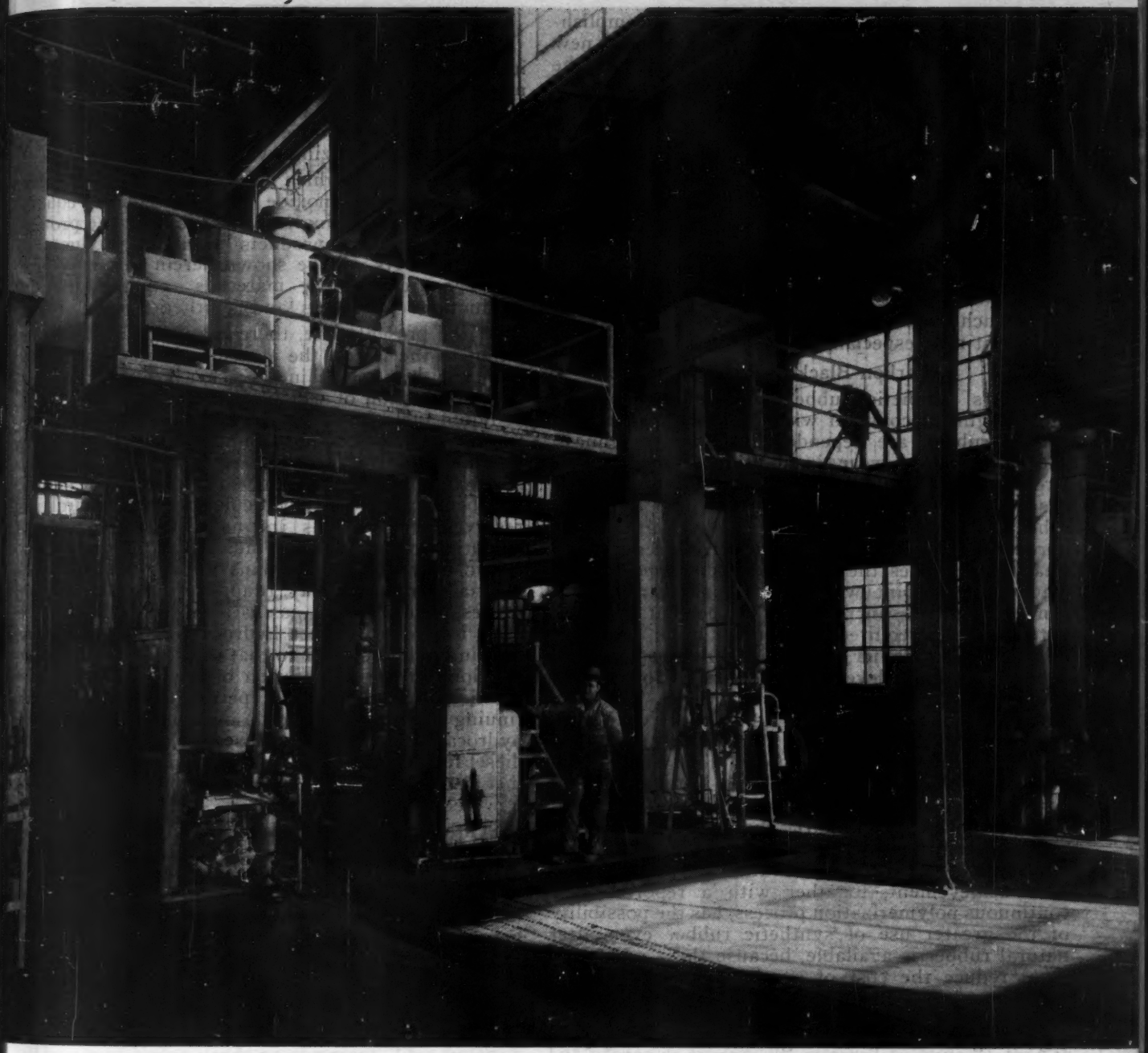
The authors have coined a new word "Synthine" for Fischer-Tropsch processing and singled out the making of an ingredient for improving knock rating of diesel fuel.

Certainly the reserve of energy from hydrocarbons has been enhanced by what the chemist has learned about processing natural gas, and he will continue to improve the reserve total as he learns more.

This paper was delivered before the meeting of the Texas Academy of Science in Galveston, November 10, 1944.



Piston gauge pilot valve and separator assembly installed in rear of truck body, Bureau of Mines mobile testing laboratory for making analysis of hydrocarbon fluids coming from gas-condensate reservoirs.



Equipment in which helium is separated from natural gas at Bureau of Mines Helium Plant at Amarillo, Texas

production of enormous quantities of aviation fuel. To power long-range bombers and fighter planes, super fuels high in octane value must be produced. These fuels must be capable of developing maximum power at full throttle to better enable heavily-laden planes to take off and to climb and fight as conditions of war dictate—this property, termed "rich-mixture rating," must be accompanied by a suitable "lean-mixture rating" to enable the power unit to operate efficiently when cruising to and from the target or battle area. Thus, into one fuel is blended ingredients to insure the power and efficiency, prerequisites in all phases of modern aerial warfare. To effect this, the liquid fuel to power planes consists of a definite blend of base stock, iso-octane alkylate, isopentane, tetraethyl lead, ethylene dibromide, together with additives of more recent perfection, like cumene, 2,3 dimethyl butane and others that cannot be reported due to restrictions. It is true that the greater proportion of this fuel finds its origin in petroleum; however, it is equally true that the natural gasoline fluids produced from the natural gas, oil, and condensate fields of the nation contain a far greater proportion of the key or critical components than are found in an equivalent volume of crude oil. These accomplishments are only made possible by the scientist's ability to reduce, rearrange, and combine the molecules of petroleum and natural gas into definite geometric molecular patterns. In ever striving to perfect newer and better aviation fuel, it appears that the gas chemists find their syntheses from concentrated light hydrocarbon fractions of ever increasing importance with unlimited possibilities. Thus, natural gas, although not the bulk raw material of our present and future aviation fuels, continues as one of the major sources for the production of superquality ingredients.

Rubber, quickly and in large quantities, was and is a wartime "must." Every trick and process known to science has and is being tried to make more and

better synthetic rubber. The amazing accomplishments in the development and production of our new synthetic rubber, however, cannot reflect truly the terrific pace the rubber chemist has set to bring this about. To produce butadiene, one of the most important ingredients of synthetic rubber, approximately 100 actual and theoretical methods exist for its synthesis, while a dozen or more known methods are being practically employed for its production. Products extracted from natural gas are not the major raw material in the production of butadiene, being employed in only 13 percent of the present authorized rated plant capacity. However, in the production of other rubber "musts," like styrene and fillers such as carbon black, natural gas plays an important role, especially in the latter.

Carbon Black in Rubber

Today's synthetic rubbers, wherever they find their origin, in common with the liquid latex from natural rubber, are dependent for their toughness, and resistance to wear, in addition to their tensile strength, upon a submicroscopic derivative of natural gas—carbon black. Natural rubber and synthetic rubber have unusually low tensile strength in the pure state. To produce the desired strength and wearing properties, the scientist has developed carbon black to the point where the tensile strength of synthetic rubber is increased by 600 percent. Whereas natural rubber required one type of black, paint another and ink another, synthetic rubber requires yet another. With the development of satisfactory carbon blacks for the compounding of synthetic rubber, a new problem, or bottleneck, was encountered, that of compounding the black with the rubber.

Thus, if the production of synthetic rubber was yesterday's problem, its processing is today's. Once again the scientist has made available new processes whereby carbon-black slurry is added to the liquid rubber, permitting a finished rubber with perfect distribution—a natural blend rather than mechanical. This achievement, together with a reported new continuous polymerization process, has the possibility of the greater use of synthetic rubber even after natural rubber is available, because these new processes reduce the cost of synthetics in addition to producing a better product. These developments are continuous, with one of the latest and most outstanding being that of including a carbon chain, thus producing electrically-conductive rubber. Thus the dreaded ice formation upon airplane wings may be better eliminated by electrically-heated rubber covering. Also, electrical-conductive products may allow for the dissipation of electric charge heretofore suspected as the cause of unaccounted for accidents. Again it appears that predictions, frequently voiced in the past, to the effect that synthetic-rubber products or synthetic natural-rubber blends would produce superior products at a lower cost than those manufactured exclusively with natural rubber, each day draw closer to reality.

The use of natural gas as a raw material in highly efficient processes requiring a minimum of new critical construction materials has made possible the production of the immense quantities of explosives required for the war. The significance of ammonia in the production of explosives is well-known. Modern block busters find formaldehyde, ammonia, together with nitric acid, indispensable for the production of one of its major ingredients—hexogen. The production of these materials from natural gas has thrust the latter to the fore in the present emergency.

Natural Gas and Steam

Probing more closely into these accomplishments, it may be noted that this, to a great degree, has been made possible by the development of a process in which natural gas and steam react to produce hydrogen or a mixture of carbon monoxide and hydrogen with amazing overall yields.

This process by which natural gas and steam react to form carbon monoxide and hydrogen is equally important in supplying raw materials for the production of peacetime products as it is products of destruction. As will be shown herein this may be a major source of raw materials required for the production of plastics and synthetic fuels.

At the present time, there is much discussion relating to the use of the aforementioned process, together with the Synthine (Fischer-Tropsch) process, the combination of which allows for the production of liquid fuels from natural gas. Naturally, the perfection of such a combination of processes to produce liquid hydrocarbon fractions on a favorable economic basis could result in an enormous quantity of natural gas being used, thereby depleting our natural gas reserves. This means improbable, although the operation of pilot plants indicates a favorable economic conversion, with plans for at least one commercial plant under way. It appears that the Synthine process using natural gas as a raw material may be used to produce select hydrocarbon fractions, performing a duty similar to that of propane and butane fractions in the preparation of key components for aviation fuel—the bulk of petroleum fractions continuing to come from crude oil. One of these select hydrocarbon fractions increases the cetane number of diesel fuel and gives promise of remarkable improvements to the present fuel supply for many diesel-powered ships.

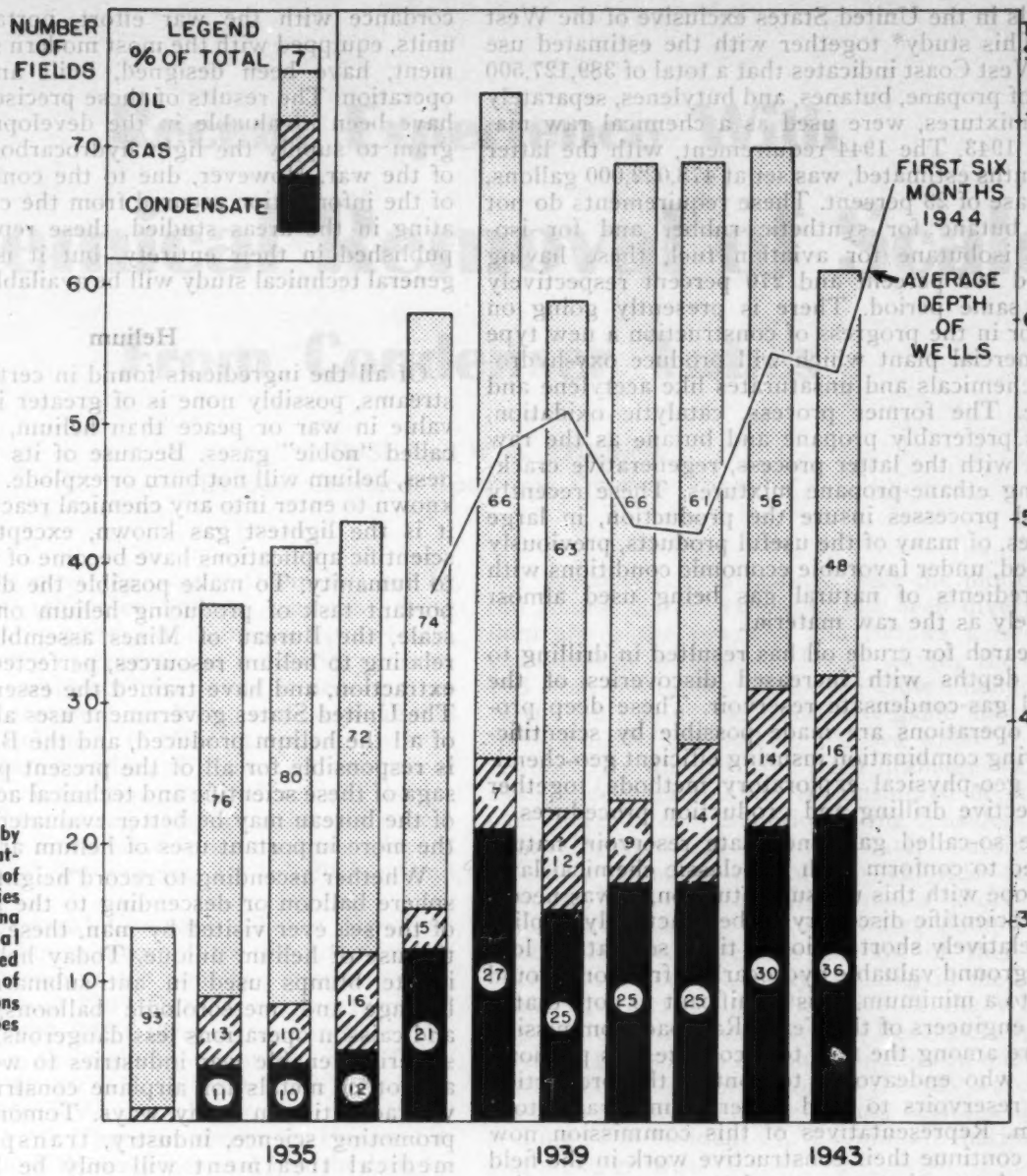
Synthetic plastics are fast becoming wartime substitutes for critical materials, while some of them are among the critical materials themselves because of superior qualities for certain specialized uses. In his development of plastics, the scientist has opened new fields in which they exhibit unique properties. Some are like glass, others rubber, some resist corrosive chemicals of all types, still others exceed the resistance to vibration and fatigue failure that conventionally used metals exhibit.

Into Plastics

In this paper it is impossible to discuss exhaustively the properties and uses of all plastics for they appear to exist in endless numbers. However, a few of the more outstanding, which proven processes may produce from natural gas as the major source material, will be set forth.

The gas chemist has used an invisible thread to produce the acrylic resins presently marketed under the trade names of Lucite and Plexiglas. This nonshatterable plastic, approaching invisibility through transparency, assures maximum visibility and security to pilots, bombardiers, and gunners, is but one of the wartime wonders of the scientist. Additional properties like superior transmission of light over glass, the piping of so-called cold light, the ability to transmit the germ-killing ultraviolet light, should find it extensively used to insure brighter, healthier homes of tomorrow.

As the scientists' knowledge of the larger molecule progressed, it was soon evident that the preparation of purely synthetic fibers and filaments was possible.



This chart, prepared by Natural Gas and Natural Gasoline Division of PAW, shows discoveries in Arkansas, Louisiana and Texas Coastal area. It is to be noted the importance of lighter hydrocarbons grows as drilling goes deeper.

Thus, the perfection and production of Nylon, Vinyon and Saran followed each other in rapid succession.

The use of Nylon needs no comment. This superior form of fabric presently going directly into the war effort finds natural gas playing only an indirect role in its synthesis; however, Vinyon and Saran may be produced from the derivatives of natural gas under favorable economic conditions.

Vinyon, like Nylon, possesses high tensile strength, is odorless, tasteless, does not support combustion, and is permanently water-resistant and mildew-proof. Naturally, it too plays an important role in the war. Recently perfected processes suggest it will be made available in ever increasing amounts through the use of hydrocarbon gases as raw material.

Saran, another filament, is remarkably beautiful in appearance, strong, durable, tough, flexible, abrasive resistant and immune to soaps. Saran should find widespread use for many applications like draperies, upholstering, etc., in addition to its outstanding application in the form of non-corrosive, non-heat conducting window screening.

As in the above, scientific progress insures the production of many valuable finishing agents, solvents, plasticizers, detergents and synthetic lubricants. Just to what extent natural gas will serve as a major raw material cannot be determined at present, but processes previously referred to suggest that it may be a source raw material in the production of the important ethenoid and formaldehyde resins.

In order that scientific accomplishments may be beneficial to mankind, they must be of proven practical use—produced on a desirable economic basis. Thus, the contribution of natural gas in such proceedings resolves itself into a quantitative study. A greater portion of the dry natural gas, chiefly methane, presently being converted into chemicals, finds its major end product explosives, thus the results of such a study are restricted.

Growing Use

It has been pointed out that although dry natural gas is of importance as a chemical raw material, especially in the production of hydrogen, water gas and ammonia, present trends suggest that the heavier fractions, like ethane, propane, and butane, are more desirable for chemical processing.

A recent study of the production and disposition of liquefied-petroleum-gas products by a special subcommittee included their use for the production of

chemicals in the United States exclusive of the West Coast. This study* together with the estimated use on the West Coast indicates that a total of 389,127,500 gallons of propane, butanes, and butylenes, separately and as mixtures, were used as a chemical raw material in 1943. The 1944 requirement, with the latter nine months estimated, was set at 478,022,000 gallons, an increase of 23 percent. These requirements do not include butane for synthetic rubber and for isomerized isobutane for aviation fuel, these having increased 260 percent and 270 percent respectively for the same period. There is presently going on stream or in the progress of construction a new type of commercial plant which will produce oxy-hydrocarbon chemicals and unsaturates like acetylene and ethylene. The former process, catalytic oxidation, employs preferably propane and butane as the raw material with the latter process, regenerative cracking, using ethane-propane mixtures. These recently perfected processes insure the production, in large quantities, of many of the useful products, previously mentioned, under favorable economic conditions with the ingredients of natural gas being used almost exclusively as the raw material.

The search for crude oil has resulted in drilling to greater depths with increased discoveries of the so-called gas-condensate reservoir. These deep production operations are made possible by scientific-engineering combination insuring efficient geo-chemical and geo-physical exploratory methods, together with effective drilling and production procedures.

In the so-called gas-condensate reservoir, nature has failed to conform with the classic chemical laws and to cope with this unusual situation, it was necessary for scientific discovery to be practically applied over a relatively short period of time, so that the loss of underground valuable hydrocarbon fractions would be held to a minimum. It is significant to note that it was the engineers of the Texas Railroad Commission who were among the first to recognize this phenomena and who endeavored to control the production in such reservoirs to hold underground waste to a minimum. Representatives of this commission now actively continue their constructive work in the field and it is interesting to note that more progressive state regulatory bodies are now cognizant of these problems and are taking steps to insure the underground conservation of select hydrocarbon fractions.

Condensate Fields

The Petroleum and Natural Gas Division of the Bureau of Mines has turned virtually all its studies in the direction of supplying information needed by the Petroleum Administration for War and by the petroleum industry in conducting the war program. Two of the least publicized tasks entrusted to this division of the bureau have been the study of condensate fields and their products and the program of supplying the large quantities of helium required in the war effort.

The study on condensate fields and their products includes a complete analysis of the stabilized flow stream of both the gas and liquid under separator pressure and temperature, together with an estimate of reserves of condensate and probable recovery factors, supplemented with geological and engineering data. In securing all the essential data required to evaluate the productivity of condensate fields in accordance with the war effort, portable laboratory units, equipped with the most modern scientific equipment, have been designed, built and are now in operation. The results of these precise investigations have been invaluable in the development of a program to supply the light hydrocarbon requirements of the war. However, due to the confidential nature of the information secured from the companies operating in the areas studied, these reports cannot be published in their entirety, but it is hoped that a general technical study will be available after the war.

* The data reported herein are taken from the preliminary report of a special LP-Gas Industry Committee and are subject to revision.

Helium

Of all the ingredients found in certain natural-gas streams, possibly none is of greater importance and value in war or peace than helium, one of the so-called "noble" gases. Because of its chemical inertness, helium will not burn or explode. It has not been known to enter into any chemical reaction and in that it is the lightest gas known, except hydrogen, its scientific applications have become of invaluable help to humanity. To make possible the difficult and important task of producing helium on a commercial scale, the Bureau of Mines assembled information relating to helium resources, perfected means for its extraction, and have trained the essential personnel. The United States government uses about 98 percent of all the helium produced, and the Bureau of Mines is responsible for all of the present production. The saga of these scientific and technical accomplishments of the bureau may be better evaluated when some of the more important uses of helium are considered.

Whether ascending to record heights in the stratosphere balloon or descending to the greatest depths of the sea ever visited by man, these operations find the use of helium unique. Today helium is used to inflate blimps used in anti-submarine patrol, fill barrage and meteorologic balloons, make diving and caisson operations less dangerous, relieve human suffering, enable war industries to weld magnesium and other metals for airplane construction, and aid war activities in many ways. Tomorrow its use in promoting science, industry, transportation, and medical treatment will only be limited by the scientists' ability to effect its maximum value.

Fear has been defined as "lack of confidence." Certainly, the lack of confidence recently voiced in many circles relating to our future petroleum reserves is not justified in view of the scientists' record to date. Scientific achievements in the past suggest that, as new problems arise in the exploration for and development of petroleum deposits throughout the world in locations heretofore considered difficult or impossible to pursue, their solution will not be wanting. It is true that the quantity of petroleum and its products concealed within the earth is of a definite magnitude and that it is not being replaced as produced; thus, the scientists' activity is necessary and of value in securing a maximum recovery and efficient use of this natural resource during its productive period. As we draw near the end of world petroleum resources, which does not appear imminent in our normal span of life, we are assured not only of constantly improving products but also of satisfactory substitutes produced from enormous stores of other natural material resources—all to be realized through the technologists' accomplishment of the scientists' dream. We have definite assurance of such things to come, witnessed by the amazing progress during the present emergency, through science in natural gas.

Recent Experience With
Chemical Removal of Scale
From Condenser Tubes

J. S. RUSH and W. S. JENNINGS
The Dow Chemical Company, Freeport, Texas

IN ORDER to meet the overload demands set by war production schedules and to maintain those schedules over long periods of continuous peak loads, the power industry in general and industrial generating stations in particular have found it necessary to adopt new maintenance methods, tools and agents to keep power equipment in efficient operating condition. The prewar practice of removing equipment from service for inspection and maintenance is not always included in setting today's production schedules. Some of the new maintenance methods adopted through necessity are proving to be efficient and practical.

The Dow Chemical Company (Texas Division) Freeport power house incorporates six turbogenerators driven by steam at 400 pounds per square inch, gauge, pressure and 750° F. total temperature. All generators are 3600 RPM three-phase machines delivering power on the main busses at 13.8 KV. Three units are rated 20,000 KW (25,000 KVA), two are 7500 KW (10,700 KVA) machines, and one 10,000 KW (12,500 KVA). The unit shown in Figure 1 is one of the 20,000 KW machines and has the longest station service record. This machine is the No. 1 unit referred to later in this article. The 10,000 KW unit is non-condensing and exhausts into a 30-pound per square inch, gauge, process steam system. The two 7500 KW units are automatic 30 pounds per square inch extraction turbines exhausting steam in excess of extraction demands to surface condensers. The three 20,000 KW units are normally operated full condensing. Two of these larger units are equipped with extraction for emergency or future use.

All condensers are single-pass surface condensing with divided water boxes and using sea water supplied by two electrical motor-driven pumps. Figure 2 is an end view of the pump side of condenser No. 3 and is identical with the condensing units on machines No. 1 and No. 6. Condenser tubes are No. 18 BWG 7/8-inch aluminum brass with flared inlets and rolled into Muntz metal tube heads. The three full condensing turbines are equipped with condensers rated 187,000 pounds of steam per hour with 17,800 square feet effective surface, 3240 tubes, and requiring 33,600 GPM of sea water. The condensers on the automatic extraction turbines are rated 100,000 pounds of steam per hour with 8780 square feet effective surface, 2130 tubes and requiring 22,000 GPM of sea water.

Condenser-cooling water is sea water taken from the Freeport harbor channel near the mouth of the old Brazos River. The river has been diverted by a dam above the townsite and follows a new direct channel into the Gulf of Mexico leaving the old river bed from the townsite past the Dow Chemical plant to the Gulf as a year round navigable ship channel, turning basin and harbor. The sea water in the ship channel is ordinarily free from drainage water dilutions and contamination is considered negligible. A past source of contamination rating consideration was a sizeable discharge of waste water containing considerable amounts of calcium chloride and some residual lime entering the chanel a short distance below the intake of the sea water pumps. During flood tide a considerable amount of this material could be noticed as a milky turbidity in the sea water flume. An increase in alkalinity of the water was noticeable during these periods. Recent changes have diverted this source of contamination to another disposal channel. Chlorination of the sea water in the main flume has been maintained between 0.2 PPM and 0.4 PPM residual Cl_2 to eliminate marine animal and algae growth.

Due to a favorable power factor load, all generators are normally operated in excess of their KW ratings. The condensers of the three 20,000 KW units regularly handle 15 to 20 percent more than their rated steam capacity. The two automatic extraction turbines normally operate with condenser loadings well below their guarantee ratings. Heat transfer in the three large condensers is a factor reflected materially in the economy of operation. High hydraulic friction losses, tube flow restriction and scale deposits on tube surfaces become maintenance problems of the first order under these operating conditions. Inspection of condenser surfaces a short time after the units were put into operation disclosed that a deposit of dark brown scale was collecting on the tube surfaces. Pneumatic-driven rubber cleaning plugs failed to remove this scale but removed silt and shell accumulations. Marine debris and trash were reduced to a minimum by three screening operations at separated points in the pumping and distribution system. Standpipe-type manometers were installed on the discharge lines of the condenser circulator pumps to indicate tube fouling and pump performance. Every opportunity was utilized to clean trash from the water boxes and to remove obstructions from the tube inlets.

At the end of 10,000 hours of service Turbine No.

1 was removed from service for inspection and maintenance repairs. The condenser water box heads were removed and the tubes cleaned with a water-lubricated wire brush. Tube tests made following the cleaning showed 32 tubes to be defective and leaking. One tube was removed for inspection and replaced with a new tube. The remaining 31 defective tubes were sealed off with wooden plugs. One tube failure was identified as wet steam erosion from a turbine drain discharging into the condenser and a baffle was installed to eliminate future difficulty. Water erosion, dezincification and fabrication defects were charged with causing failure in the other tubes removed from service. Failure in most cases developed at a point approximately 6 inches from the inlet end of the tube. All plugged tubes were removed after 17,000 condenser service hours. A total of 46 defective tubes were replaced with new ones at this time.

A short period of lowered load demand developed after 20,000 service hours allowing time for inspection and the cleaning of all condensers with pneumatic-driven rubber plugs. Job time and costs ran higher on this work than was planned due to the hard scale deposited on the tube walls causing the plugs to stick in the tubes and requiring vigorous rodding to remove them. This difficulty was of course more pronounced in the condensers with longer service records. Condenser performance was as a whole very little better following this method of cleaning. The consistent trend toward lowered heat transfer rates insistently demanded solution of the scale-elimination problem.

Scale formation in Condenser No. 1 after 25,000 hours of service was affecting the heat transfer to a degree intolerable with economy of operation. Condenser tests showed that the coefficient of heat transfer had dropped to 330 Btu per square foot degree hour at rated load against a clean tube corrected value of 591 Btu. These values converted into terms of cleanliness factor gave the low value of 55.8 percent. The load on Generator No. 1 was lowered to 80 percent rated and the cooling water removed from one side of the divided water box. The head was removed from the water box out of service and the tubes rodded with a stiff wire brush. Tubes were now coated with scale until the wire brush was forced through the tubes with extreme difficulty and the operation was completed with man-hour charges in

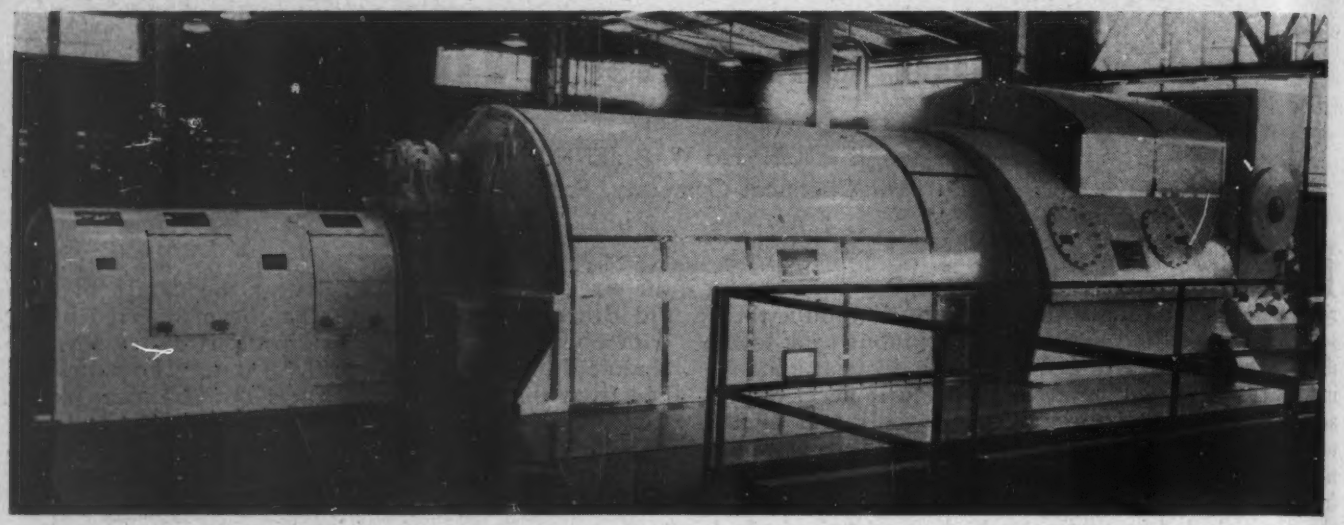


FIGURE 1

Turbogenerator Unit No. 1, one of six in the power house of Dow Chemical Company at Freeport, Texas, shown with a section of the 13.8 KV switchboard in background. This unit is rated 20,000 KW (25,000 KVA) and has the longest service record of the units furnishing power for the big plant.

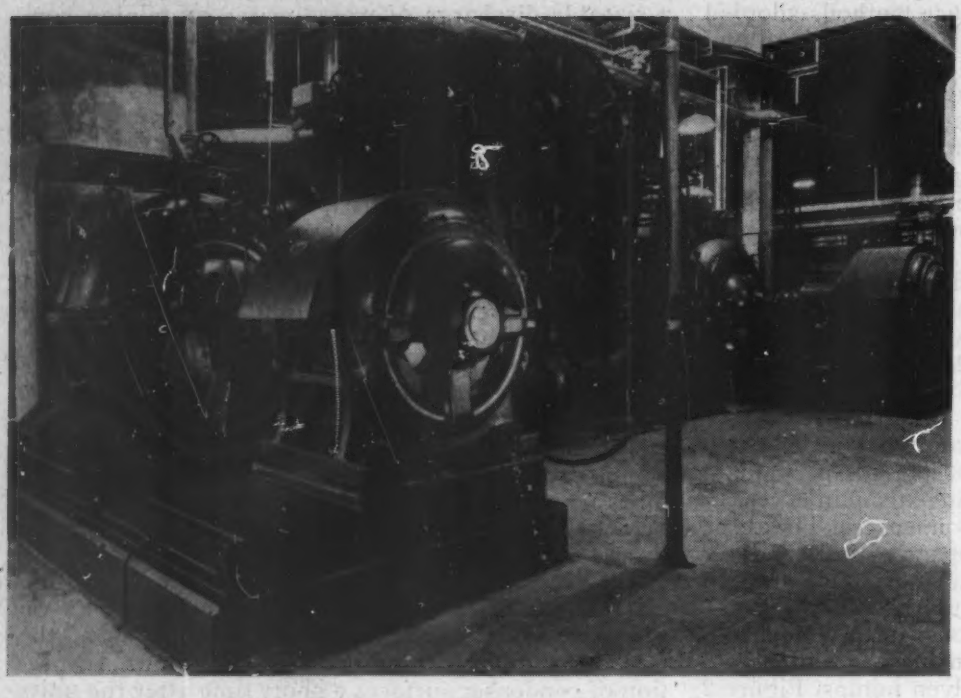


FIGURE 2

Condenser No. 3 as viewed from the pump end. This equipment is identical with the installations on Units No. 1 and No. 6.

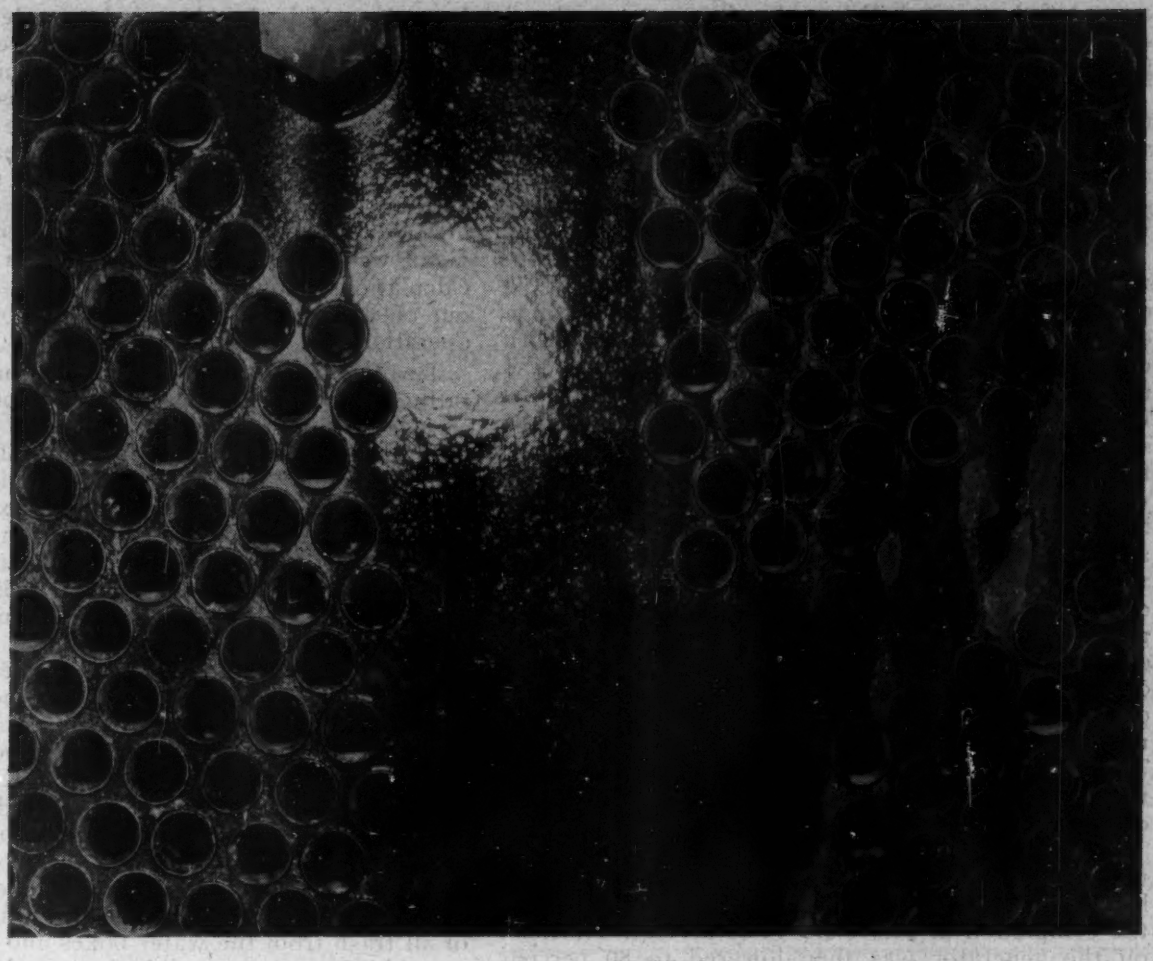


FIGURE 3
Condenser No. 3 inlet tube head and tube ends, showing scale deposits before treating with a chemical solvent.

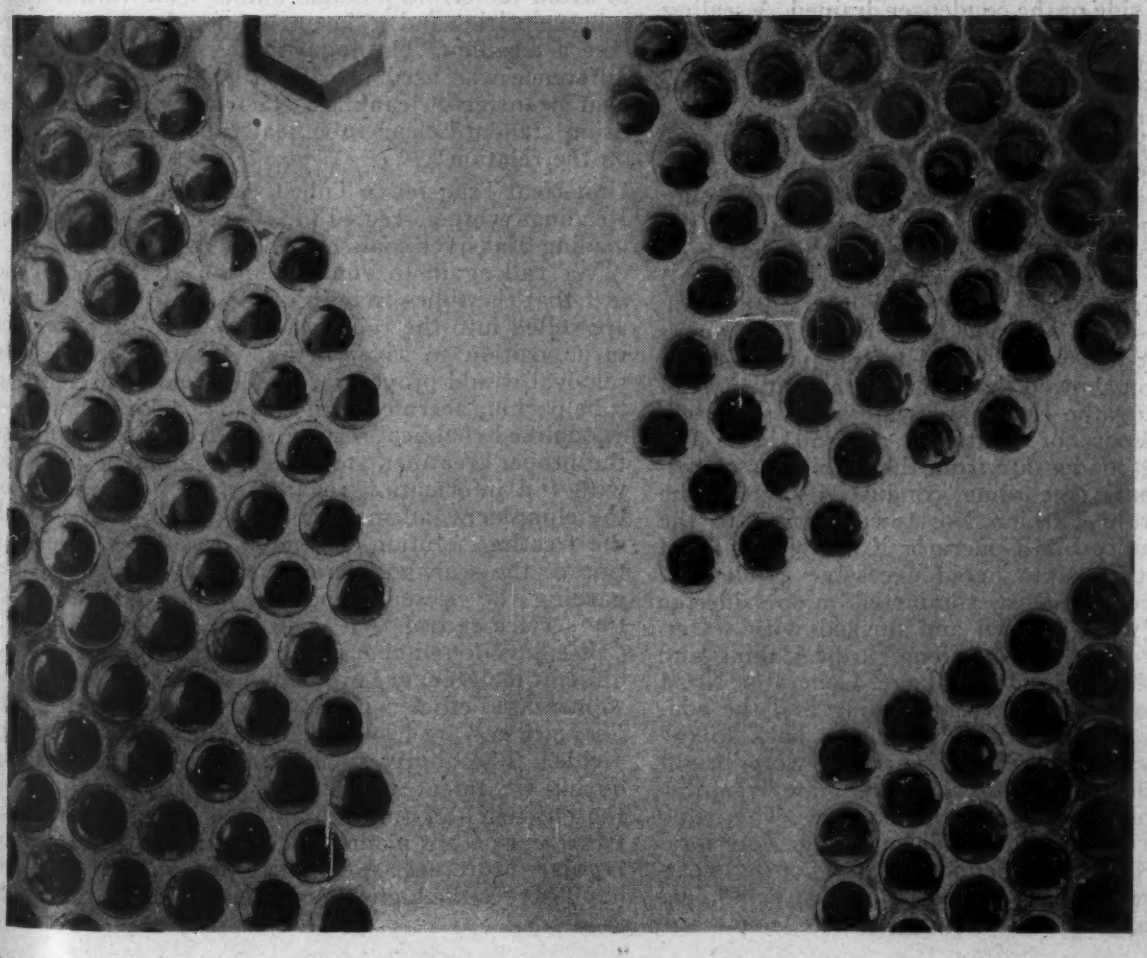


FIGURE 4
Condenser No. 3 inlet tube head and tube ends following treatment with a chemical solvent. Same section shown in Figure 3, above.

excess of the normal. When cleaning was completed condenser performance tests showed the cleanliness factor to be 62.0 percent or an increase of 6.2 percent. The resistance of the scale to wire brushing indicated the need of a more effective tool. It was decided that a small diameter pneumatic-turbine-driven descaling tool would be required. The generator load was again lowered to 80 percent rated and a total of 42 hours were spent removing the scale from the tubes in one side of the condenser with the air-driven tool. Considerable amounts of scale cuttings accumulated in the discharge-water box and it was necessary to change cutting bits on the tool every 8 hours due to worn cutting heads. Care in operation of the tool was necessary to avoid damaging the tube metal. It was found impossible to remove all scale from the tube surface without damaging the tube. A condenser performance test run following the descaling of one side with the air-driven tool showed the cleanliness factor had increased to 63.5 percent. It was decided that this small 1.5 percent increase did not justify the time and expense necessary to descale the other side of the condenser. A chemical analysis of the scale cuttings removed by the air tool revealed a high percentage of calcium carbonate which suggested the possibility of using a chemical solvent. The scale analysis, condenser dimensions and metal specifications were submitted to the engineers of Dowell Incorporated. These men have pioneered the use of chemical solvents for removing scale from boilers, heat exchangers and other industrial equipment.

Following the decision to remove the scale from the condenser with chemical treatment a period of heavy-load demand did not allow further action until the completion of 27,500 hours of service. The load on the generator was then lowered to 80 percent rated and one side of the condenser drained. A sealing plate was installed in the discharge line flange and a 2-inch chemical treating inlet connection attached to drain line in the lower part of the water-box inlet line. The drain line can be identified in Figure 2 near the floor on the right-hand side of the sectionalizing valve in the circulator discharge paralleling line. A similar connection was installed by removing a plug threaded in the top of the discharge-water box for the solvent-return line. Dowell service engineers ran hose lines to these connections and a third was connected to the plant fresh-water system for dilution control. A chemical solvent solution was circulated through the condenser-water boxes and tubes until the discharge solution showed that chemical action between the solvent and the carbonate scale was completed. After three hours of treatment a small leak contaminated the condensate from the turbine as shown by an automatic recording conductivity cell. The condensate from Turbine No. 1 was turned to the sewer and the load on Generator No. 1 was reduced to 50 percent rated to avoid excessive condensate loss. When treatment was completed on one side the water boxes were drained and flushed with water. Two staybolt gaskets were found to be leaking and were replaced stopping all leakage. Generator No. 1 was raised back to 80 percent loading and the condensate from Condenser No. 1 turned back to the feed-water system. The tube surfaces were bright and clean. All traces of scale were gone from the tube sheets, tubes and water-box surfaces. The metal surfaces were in excellent condition and no deterioration was chargeable to chemical action. During treatment of the remaining half of the condenser no condensate contamination or leakage was encountered. Inspection of both sides of the condenser following completion of the treatment showed both sides equally clean indicating that chemical treatment would have made unnecessary any mechanical cleaning methods. Condenser performance tests run following the treatment showed the cleanliness factor had increased to 78.5 percent. The steam rate on Turbogenerator No. 1 dropped 9.4 percent due to lower exhaust pressure. The cost of chemical treatment was compared with projected savings. The calculations showed the treatment costs were paid out of economy savings at the end of 502 hours of operation.

Turbine No. 3 is indentical in construction and rating as No. 1. This machine had completed 21,100 service hours and scale had lowered the condenser cleanliness factor to 65.5 percent. Treatment was completed in 12 hours with the machine carrying 80 percent rated load. No leakage was experienced during the treatment and the same efficient scale removal resulted as in the case with No. 1 unit. Condenser-performance tests showed the cleanliness factor increased to 79.6 percent due to scale removal. Figure 3 shows a section of the inlet tube end and tube sheet of condenser No. 3 before chemical treatment. Figure 4 is the same section following treatment.

All performance tests on condensers for comparison were run at rated load. Steam-flow readings were corrected for temperature and pressure. KW readings for computing steam rates were calculated by stop watch timing KWH meters. 1/10° F. calibrated mercury thermometers were located in thermometer wells in the inlet and discharge lines of the condenser under test. All condenser tests were run following removal of all trash from the water boxes and the tube inlets to avoid the errors possible due to wide variations in tube velocities and to keep the effective cooling surface a constant. The logarithmic mean temperature difference was used in calculating the coefficient of heat transfer. Cleanliness factors were calculated using standard clean tube heat transfer curves based on the relation:

$$\text{Unit Heat Transfer} = \text{Tube Constant}\sqrt{\text{Tube}}\ \sqrt{\text{Velocity}}.$$

Readings were corrected for condenser surface steam loading and inlet cooling-water temperature.

We call again to your attention at this point the fact that the tubes in both condensers here discussed are rolled into the tube heads. We are therefore not in a position to say whether this method of scale removal would prove practicable in condensers using tube packing ferrules with various packing materials. A qualified chemical service engineer can best advise the proper treatment to use. He should be provided with full information regarding the construction of the equipment, all materials coming in contact with the treating solution, a sample or complete description of the scale to be removed and an estimate regarding the present condition of the equipment or the service record.

We have found chemical treatment the answer to a difficult maintenance problem. Calculated savings due to increased efficiencies have shown us that the costs of treatment are less than 10 percent of the savings yielded. The ability to maintain 80 percent loading during treatment, the short time for completion and the efficiency of the cleaning agent places chemical treatment on our maintenance planning schedules for regular future use. We believe this method of cleaning deserves the highest consideration from the power industry.

Viscosity of Propane-Oil Mixtures

R. W. MOULTON and A. J. MITCHELL, JR.*
University of Washington, Seattle

The viscosity of propane-oil mixtures has been determined with a rolling-ball type of viscometer. The propane-to-oil ratio was varied from 1:1 to 5:1 and the temperature from —40° C. to 0° C.

MEASUREMENT of the viscosity of propane-oil mixtures has not received a great deal of attention from research workers in the past. This type of data is valuable for accurate process design calculations in many industries. The dewaxing of lubricating oil, solvent treatment of oil, and the refining of paraffin wax obtained from lubricating oil are examples of processes for which this data would be applicable.

Sage, Inman, and Lacey[7] studied the effect of pressure on the viscosity of propane-oil mixtures, but their work was done at higher temperatures (75-225° F.). A search of the literature has failed to disclose any other published work on the viscosity of this system.

Method

The apparatus used in the present investigation was patterned after that designed by Sage[6]. This

* Present address—Union Oil Company, Oleum, California.

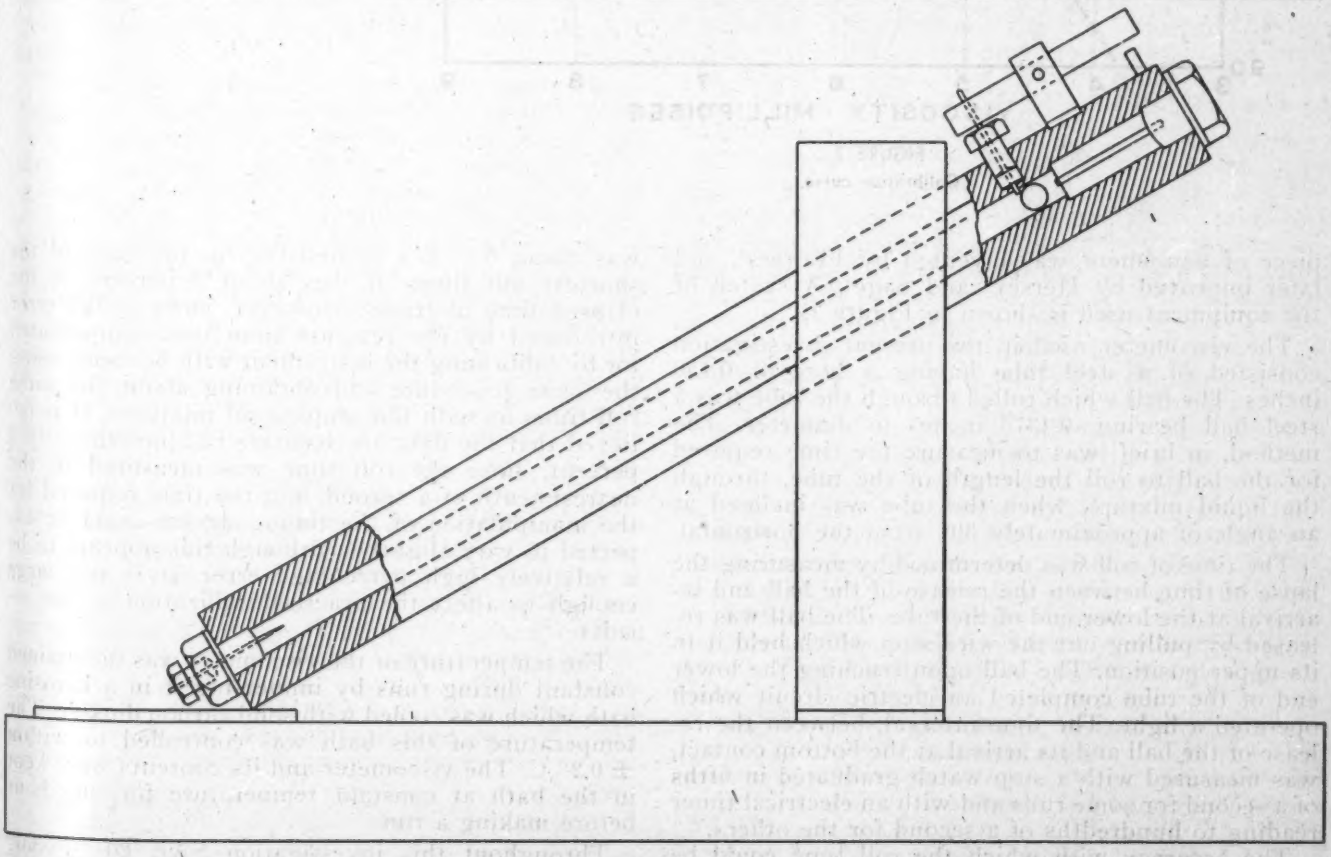


FIGURE 1
Rolling-ball viscometer.

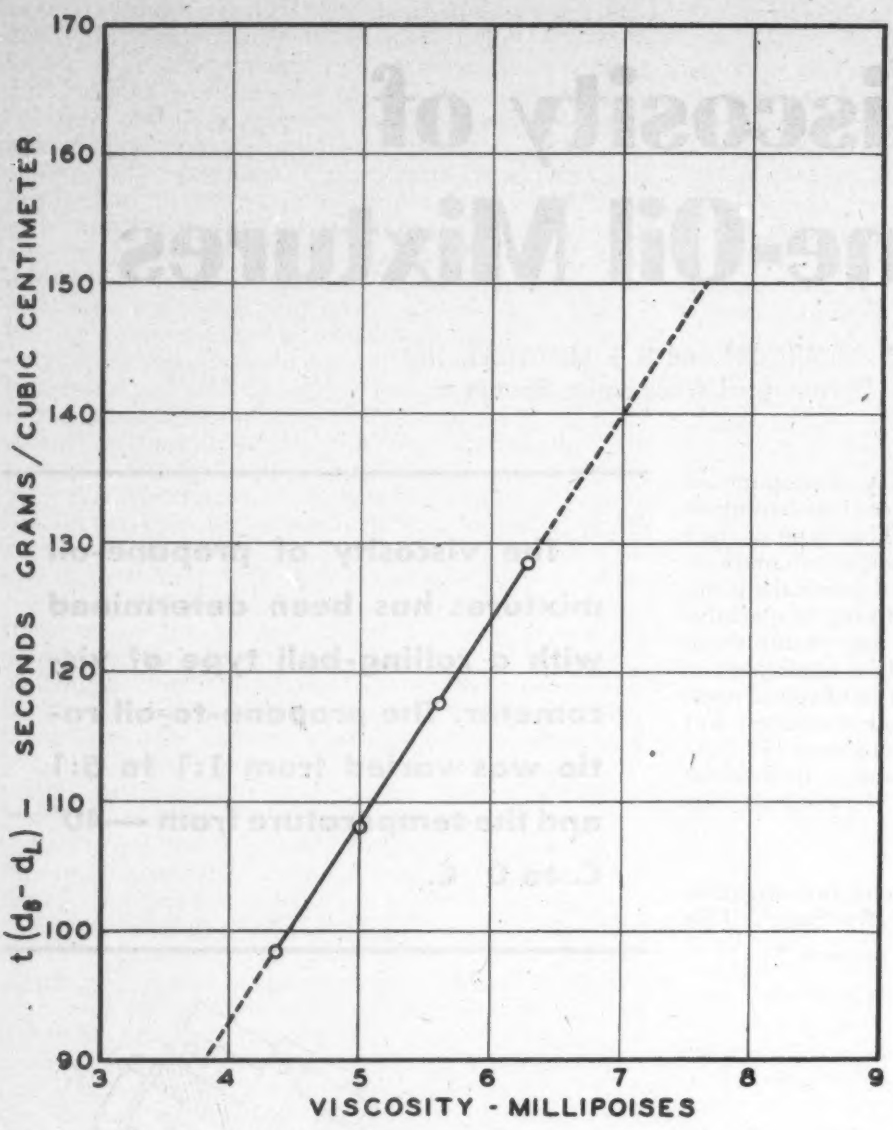


FIGURE 2
Calibration curve.

piece of equipment was invented by Flowers[1], and later improved by Hersey[2] and Sage[6]. A sketch of the equipment used is shown in Figure 1.

The viscometer used in the present investigation consisted of a steel tube having a bore of 0.450 inches. The ball which rolled through the tube was a steel ball bearing, 0.4375 inches in diameter. The method, in brief, was to measure the time required for the ball to roll the length of the tube, through the liquid mixture, when the tube was inclined at an angle of approximately 30° from the horizontal.

The time of roll was determined by measuring the lapse of time between the release of the ball and its arrival at the lower end of the tube. The ball was released by pulling out the wire stop which held it in its upper position. The ball upon reaching the lower end of the tube completed an electric circuit which operated a light. The time interval, between the release of the ball and its arrival at the bottom contact, was measured with a stop watch graduated in fifths of a second for some runs and with an electrical timer reading to hundredths of a second for the others.

The accuracy with which the roll time could be measured was affected by the time required to manipulate the stop watch or timer. This reaction time was about 0.3 of a second; or, in the case of the shortest roll times, it was about 3 percent of the elapsed time of travel. However, most of the error introduced by the reaction time was compensated for by calibrating the instrument with benzene, using the same procedure and obtaining about the same roll times as with the propane-oil mixtures. It is believed that the data are accurate to approximately 2 percent, since the roll time was measured to the nearest tenth of a second, and the time required for the manipulation of the timing device could be expected to vary slightly. Although this appears to be a relatively high percentage error, it is not large enough to affect the practical utilization of the results.

The temperature of the viscometer was maintained constant during runs by immersing it in a kerosine bath which was cooled with solid carbon dioxide. The temperature of this bath was controlled to within $\pm$ 0.2° C. The viscometer and its contents were kept in the bath at constant temperature for one hour before making a run.

Throughout this investigation SAE 20 "Tydol" motor oil, manufactured by the Associated Oil Company, and chemically pure propane obtained from

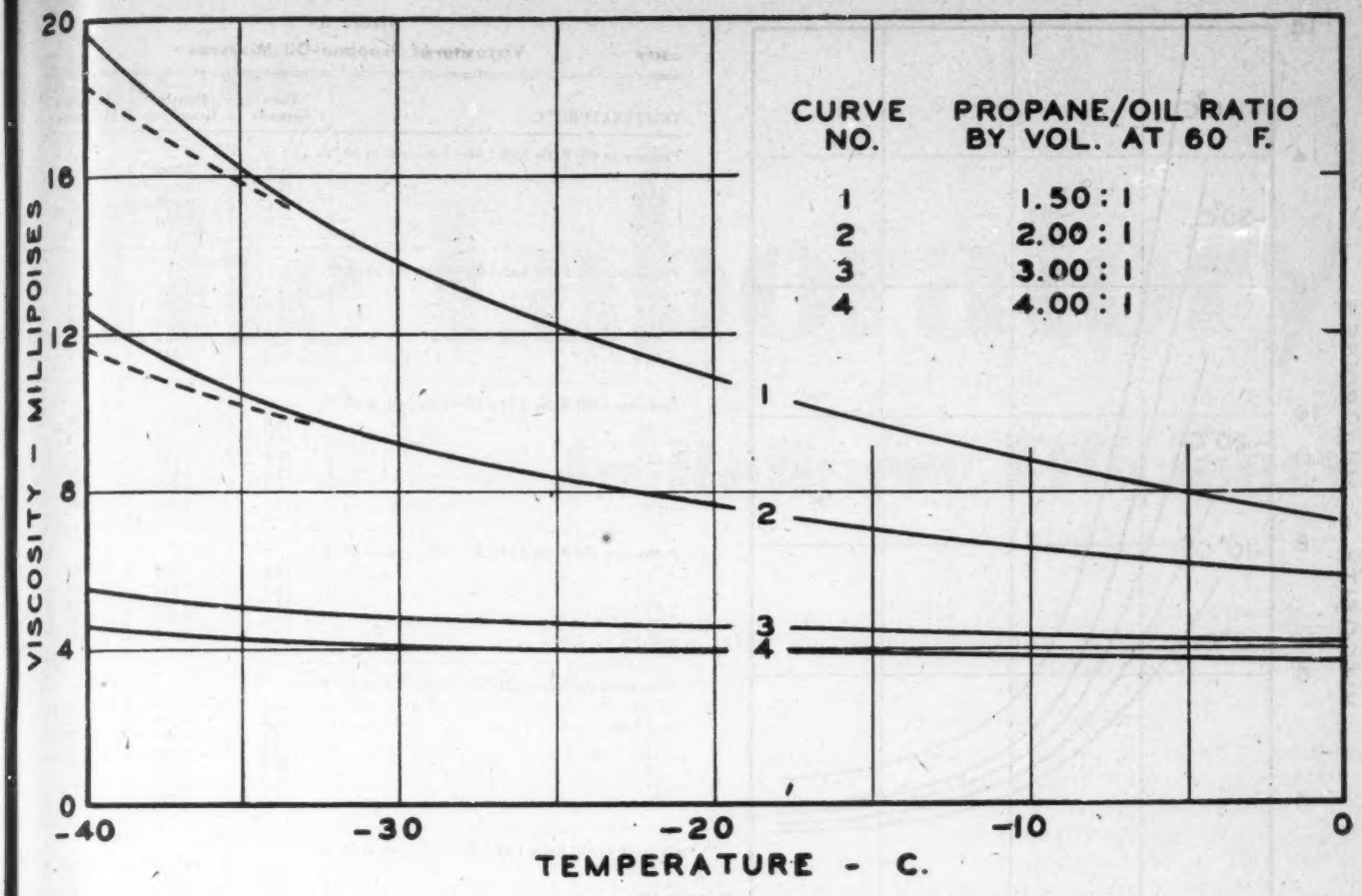


FIGURE 3

Viscosity of propane-oil mixtures as a function of temperature.

Ohio Chemical and Manufacturing Company were used.

The relative amounts of the constituents introduced into the viscometer were measured in the following manner: First, a definite volume of oil was added from a buret and the tube and contents then cooled to —50° C. Then liquid propane, which had been cooled to —50° C., was added to the viscometer, filling the tube to a fixed point. Since the volume of the tube was known, and the values for the density of propane and oil were given in the literature [3,5], the ratio of propane to oil by volume at 60° F. could be calculated. For these calculations the density of the oil at low temperatures was found by extrapolating the given data from —18° C. to —40° C. It was assumed that the volumes of oil and propane would be additive.

Calibration

The type of viscometer used for this investigation was not suited for absolute measurement of viscosity and required calibration with a liquid of known viscosity. Details of the factors involved and corrections to be made are discussed by Flowers[1], Hersey[2], and Sage[6]. These men agree that a linear relationship exists between the roll time and the viscosity of the fluid if the flow around the ball is laminar. Sage[6] suggests that the following formula be used for the calculation of viscosity in the region of laminar flow:

$$\text{Absolute viscosity} = (K)\ (t)\ (d_B - d_L) \qquad (1)$$

where "K" is a constant, its value depending on the angle of inclination, the roughness of the tube, and the diameter of the bore and ball; "t" the time required for the ball to travel the length of the tube; and "$(d_B - d_L)$" the difference between the density of the ball and the density of the liquid.

In the case where the flow around the ball is turbulent the value of K is no longer constant. A plot of viscosity against (t) $(d_B - d_L)$ gives a curve. This curve can be determined by calibrating the tube with liquids varying widely in viscosity and density.

In this investigation the viscometer was calibrated by filling the tube with pure benzene and measuring the roll time at several temperatures. These data are presented in Table 2. Since the absolute viscosity[4] and density[5] of this liquid are given in the literature for various temperatures, a plot of the formula suggested by Sage could be made (Figure 2). This plot indicates that laminar flow exists

TABLE 1

Analysis of SAE 20 Tydol Motor Oil

Gravity—A.P.I.°	25.3
Viscosity—seconds (Saybolt):	
at 130° F.	171
at 210° F.	55
Flash point—°F.	385
Fire point—°F.	450
Pour point—°F.	20
Carbon residue—percent	0.18

TABLE 2

Calibration Data

LIQUID	Temperature ° C.	Time Seconds	Density Grams/cc.	Viscosity Millipoises
Benzene	21.6	18.4	0.8762	6.28
Benzene	30.0	16.8	0.8661	5.61
Benzene	40.0	15.4	0.8544	5.00
Benzene	50.0	14.0	0.8416	4.36

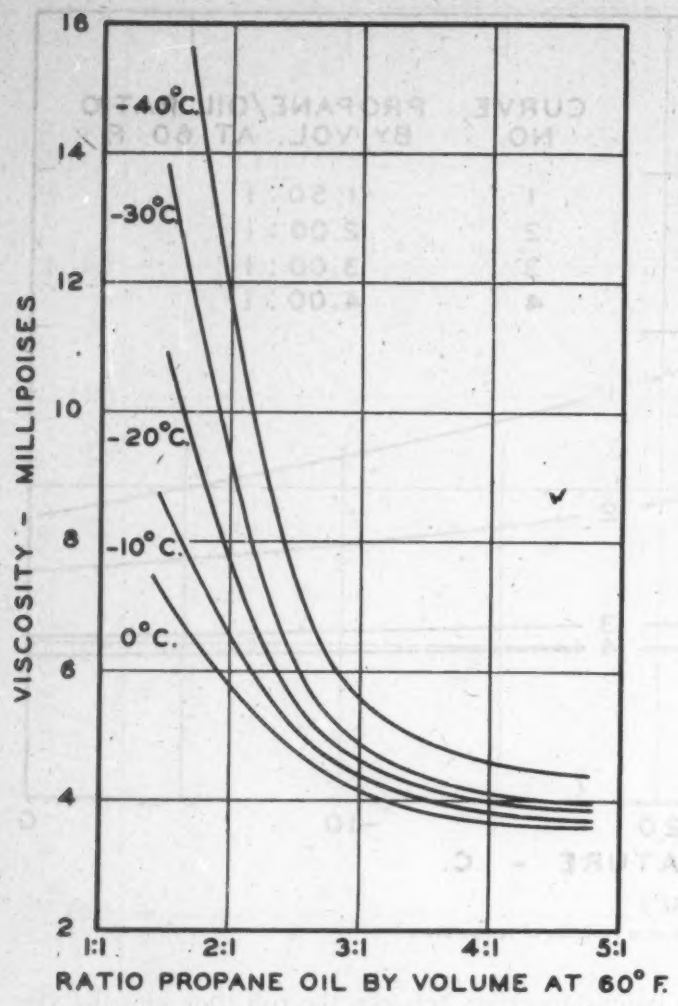


FIGURE 4

Viscosity of propane-oil mixtures as a function of the propane-to-oil ratio.

over the range of densities and viscosities investigated in the calibration. It is believed that the extrapolation of this plot to higher values of viscosity is justified, because an increase in the roll time would not change the type of flow. However, any extrapolation of the graph to read lower values of viscosity is based on the assumption that laminar flow still exists. This assumption is probably valid for the short distance the graph was extended.

Results

The effect of temperature on the viscosity of propane-oil mixtures between 0° and —40° C. is shown in Figure 3 and Table 3. The curves indicate that the variation of viscosity with temperature is greatest at low ratios of propane to oil. This is to be expected as the viscosity of lubricating oil varies much more with temperature than does propane in this temperature range. These curves also show an abnormal increase in viscosity between —30° and —40° C. This variation is believed to be due to a change in the liquid phase. At these temperatures, and with the selective-solvent action of the propane, there is a possibility of resins and/or low-melting-point waxes precipitating out. The nature and the amount of the solids coming out would depend upon the source of the oil and also upon the methods by which it was refined. For this reason, it is believed that the dotted portion of the curve shows more accurately the relationship between the viscosity of propane-oil mixtures and temperature in the region where this change in the liquid phase is occurring.

TABLE 3

Viscosity of Propane-Oil Mixtures

TEMPERATURE °C.	Time Seconds	Density Grams/cc.	Viscosity Millipoises
Propane-to-Oil Ratio 5.38:1.00—Vols./vol. at 60 °F.			
— 3.5	11.3	0.592	3.35
—14.0	11.4	0.605	3.37
—28.0	11.6	0.623	3.47
—40.0	12.0	0.636	3.63
Propane-to-Oil Ratio 4.65:1.00—Vols./vol. at 60 °F.			
— 1.0	11.8	0.597	3.55
— 8.0	12.0	0.606	3.65
—17.0	12.4	0.616	3.82
—27.0	12.6	0.632	3.92
—38.0	13.4	0.645	4.27
Propane-to-Oil Ratio 3.34:1.00—Vols./vol. at 60 °F.			
0.0	12.6	0.628	3.91
— 7.0	13.0	0.640	4.14
—16.0	13.4	0.652	4.32
—20.0	13.7	0.656	4.36
—29.0	14.0	0.672	4.53
—40.0	15.0	0.681	4.97
Propane-to-Oil Ratio 2.63:1.00—Vols./vol. at 60 °F.			
— 1.0	14.0	0.634	4.55
— 8.0	14.3	0.641	4.74
—20.0	15.2	0.656	5.08
—32.0	17.0	0.674	5.85
—38.0	18.1	0.682	6.40
Propane-to-Oil Ratio 2.21:1.00—Vols./vol. at 60 °F.			
0.0	15.6	0.649	5.27
— 4.4	16.0	0.654	5.46
— 9.4	16.6	0.659	5.72
—14.0	17.4	0.664	6.10
—24.4	20.4	0.678	7.44
—31.0	23.0	0.685	8.60
—39.6	30.0	0.695	11.78
Propane-to-Oil Ratio 1.56:1.00—Vols./vol. at 60 °F.			
0.0	19.6	0.702	7.06
—11.0	22.8	0.715	8.46
—21.0	27.1	0.727	10.48
—30.0	32.6	0.740	12.87
—38.0	42.3	0.750	16.96

Figure 4 shows the variation in viscosity of propane-oil mixtures at constant temperature as a function of the propane-to-oil ratio. The data for these curves were taken from the curves of Figure 3.

Conclusions

Viscosity of propane-oil mixtures has been determined over the temperature range —40° to 0° C., and for propane to oil ratios from 1:1 to 5:1.

Effect of temperature on the viscosity of propane-oil mixtures is greater at —40° C. than it is at 0° C.

Between propane to oil ratios of 1:1 to 3:1 the viscosity decreases rapidly as the ratio is increased. At higher propane-to-oil ratios the rate of decrease of viscosity is less.

LITERATURE CITED

[1] Flowers, A. E., Proc. Am. Soc. Testing Materials, **14**, 565-613 (1914).

[2] Hersey, M. D., J. Wash. Acad. Sci., **6**, 525-36 (1916).

[3] Mass, O. and Wright, C. H., J. Am. Chem. Soc. **43**, 1098 (1921).

[4] National Research Council, I. C. T., Vol. III, p. 29, New York, McGraw-Hill Book Co., 1933.

[5] National Research Council, I. C. T., Vol V, p. 12, New York, McGraw-Hill Book Co., 1933.

[6] Sage, B. H., Ind. Eng. Chem., Anal. Ed., **5**, 261-3 (1933).

[7] Sage, B. H., Inman B. N. and Lacey W. N. Ind. Eng. Chem., **29**, 882-892 (1937).

[8] Sage, B. H., and Lacey, W. N., Ind. Eng. Chem., **30**, 829-834 (1938).

[9] U. S. Dept. of Commerce, National Standard Petroleum Oil Tables, C 410, Washington, D. C., p. 6-32, Govt. Printing Office, 1936.

Role of The Laboratory In Refinery Efficiency

JOHN J. STADTHERR
Resident Chemist, The Pure Oil Company, Heath Refinery

IN the comparative complacency of normal peacetime, few of us fully appreciate the price which must be paid for industrial inefficiency. Foreman and managers under the pressure of stockholders and boards of directors, realize that efficiency must be had if profits are to be realized, and if dividends are to be paid. Now, however, in the thick of the world's most costly war, it is not at all too difficult to induce everyone to appreciate the full significance of lost production resulting from inefficiencies. The laborer and the executive have a common interest in seeing that the largest volume of equipment and supplies are made available for their relatives and friends at the fighting front. They realize that inefficiencies on the industrial front are being paid for with higher taxes, and will continue to be paid for by their children and their children's children. Indeed, they realize that before ultimate victory many more will pay with their lives.

There was never before a more opportune time to set up standards of efficiency by eliminating poor methods and establishing improved ones.

Certainly the refining industry has no apologies to make concerning its efficient contribution thus far to the war effort. Its part in the present production of over 800,000 long tons of synthetic rubber per year, over 500,000 barrels of aviation fuel per day, and many other notable contributions will always stand in the records as a lasting tribute to the industry's efficient capacity for production. Nevertheless, improvements are always possible. Good habits which are formed now will carry over into the post-war period when indusrial competition will be keener, and profits will not be assured by subsidy or cost-plus contracts. Perhaps we may eventually through such improvements, live down our well-earned reputation of being the most wasteful nation on the face of the earth. At least we, whose duty it is to fight on the home industrial front, should make a supreme effort to make certain that every moment counts for production, every ounce of material is made useful to the greatest possible degree, and all talent is engaged in activities conducive to an early victory. This suggests that we survey our surroundings, recognize our inefficiencies, and do something now to better the situation. Leaders in an industry so vital to our plan for victory cannot afford to do otherwise; because increased demands for all types of petroleum products, in the face of material and labor shortages, imposes on us the problem of obtaining greater efficiency than we have yet realized.

Leadership Required

Refinery managements are in dire need of leaders to supervise new operations, to instruct personnel in efficient methods, to point the way to improved operations, and to bring about waste elimination. The refinery laboratory is the logical place to look for at least a part of this leadership. This is so because the average schooling of laboratory personnel is above that of other refinery departments. While technical education alone does not make a leader, it is highly desirable in refinery supervision. Without such training, department supervisors are not equipped to make most efficient use of the laboratory's services.

If the opportunity exists, and it surely does in many refineries, the laboratory may rise to the occasion and become the watch dog of refinery efficiency, as it now is he watch dog of product quality. Unfortunately however, because of some of its unpleasant duties it becomes confined to the dog house in the esteem of other departments. When this is the case, the poor relations cause certain inefficiencies. The laboratory personnel should be trained in the methods of minimizing such conditions.

Strong Laboratory Organization Required

If the laboratory is to play an important role in refinery efficiency, specific conditions must characterize both the refinery and laboratory organizations. These conditions are:

An aggressive refinery management group (manager, superintendent, and foreman) which appreciates the value, and is able to use to the best advantage, the facilities available in a well organized laboratory.

Laboratory supervision with knowledge gained through years of study and experience plus all the other prerequisites to good foremanship.

A laboratory staff of chemists and chemical engineers whose salaries, treatment by the management group, and responsibilities make them feel their professional status, individuality, and duties as a part of management.

A laboratory building designed for efficiency and equipped with proper apparatus and supplies.

Sufficient number of trained testers, in addition to the professional people, who may be used on laboratory tasks for which professional talent is not required.

An atmosphere in the laboratory organization—from the

chief chemist to the bottle washer—which reflects a genuine desire to be of service to all other refinery departments.

Refinery Management Group

In the early days of the refining industry, there was little need for elaborate laboratory facilities because of the limited number of products, and because the properties of the early products could vary widely without noticeable affect upon their utility. However, as various new products were discovered by scientific experiments, specifications were established and refinery managements began to see the advantage of maintaining the full-time help of a chemist or two. The rapid growth of the industry was largely due to the efforts of these early scientists. Today, no intelligent refinery management would consider operations without the facilities of a laboratory and adequate staff of chemists, engineers, and testers.

Because the laboratory is a non-productive unit of the refinery, there are, unfortunately, a few who merely tolerate a laboratory in their organization because of certain product specifications, or because it was forced into the organization by outside pressure. In such organization, usually very small refineries, the laboratory is regarded as an unwanted stepchild, and a necessary evil whose only attributes are of a negative value. Where such an attitude exists on the part of management, an efficient laboratory organization is next to an impossibility because other necessary requirements as listed above are probably likewise missing.

Laboratory Supervision

The technical nature of all laboratory activities dictates the necessity of selecting personnel whose technical training is adequate, but this qualification should not by any means form the most important basis for selection. In addition, the laboratory supervisory personnel should possess the other qualifications necessary for intelligent control of labor, materials, and equipment.

The laboratory foreman and his assistant, like any foreman, should be aware that he is entrusted with the management of a concern in which the company has invested $8,000 to $10,000 (average) for every person employed. A laboratory of 50 people should be managed with the same care and responsibility as a $500,000 enterprise. The laboratory supervision should exercise such control measures as are necessary to eliminate waste of labor, materials[1], time, and energy in order that a fair profit might be possible on the $500,000 investment. Of course, they should be leaders and not drivers. This requires the ability to gain and hold the respect, confidence, cooperation and loyalty of associates and subordinates. It also requires tolerance and a broad capacity for human understanding. Other highly desirable personnel qualifications, if the laboratory is to play its role in refining efficiency, are a broad outlook gained only through experience and continuous study, good health, stamina, and imagination.

The Laboratory Technicians

In efforts to provide the laboratory department with men who have ability and satisfactory technical background, it is not enough to select the honor students from a few of the best schools of petroleum or chemical engineering, unless the good training acquired from these schools is followed up by a program of training within the refinery. This training requires the direction of one sincerely interested in the development of people for increased responsibilities. The training requires a preconceived plan which will bring young chemists and engineers in contact with refinery problems and refinery equipment. Such a plan, however, cannot be made without the help and cooperation of refinery management, particularly operations management.

Whether or not the laboratory technician wishes to remain in laboratory or research work, he will be much better qualified to render efficient service as a result of his frequent contacts with other department activities, especially with activities of the process department. If his services are later required in processing departments, he will not be entirely without experience. Here the chief chemist and his assistant has a splendid opportunity to render invaluable service as foreman-instructors. This activity depends upon the ability and experience of the chief chemist, the cooperation of other department heads, and the availability of non-technical help, either men or women, to handle routine matters. Lack of technical talent available to industry is now becoming serious and is almost certain to become even more serious, because the crop of graduating technical people for industry has been so drastically reduced by war activities.[2,3]

If the industry is to keep the technical alent it now has and at the same time be in a favorable position to hire new talent as it becomes available, many companies will have to set up a program designed to prevent technical groups from regarding themselves as "forgotten men." Such a program would consist of something such as the following:[4]

"Pay them adequately.
"Arrange satisfactory patent bonus payments.
"Credit them with a fair share of production performance.
"Guard against regimenting them.
"Make them feel secure in their jobs.
"Grant them management confidence.
"Give them plenty of newest equipment.
"Provide opportunity for training, advancement.
"Dilute engineering (and chemical) forces with women.
"Prepare for 40 X (future) engineering problems."

It is quite likely that progressive chemical-engineering management in the immediate future will follow closely a program similar to the one outlined above if it hopes to maintain an efficient technical organization. The analysis of the economic status of members of the American Chemical Society[5] will serve as a helpful guide in establishing the all important item of adequate salary.

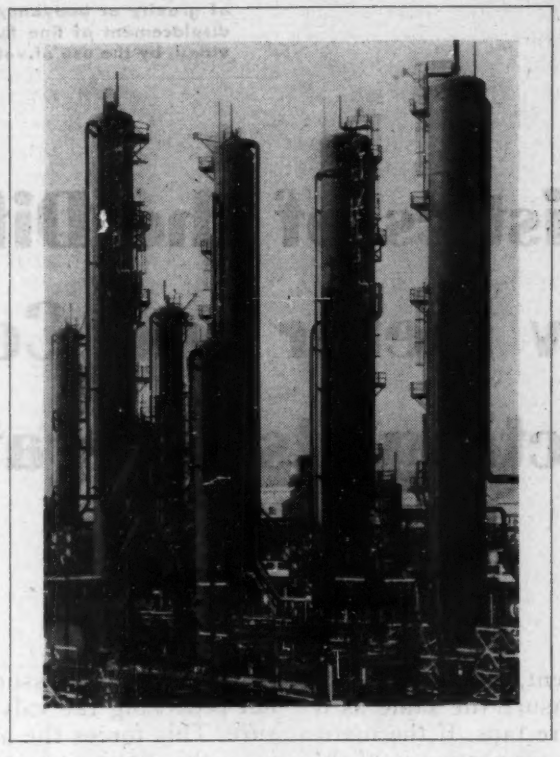
The Laboratory Building and Equipment

The thought given to the design of buildings and equipment to be used in assembly line production of tanks, planes, trucks and other implements of war should serve as a lesson to those of us who would design a laboratory for efficiency. Truly, many oil refinery laboratories were never designed, like Topsy, they just grew.[6] Too often an abandoned building which has outlived its usefulness for all other purposes, and which has very few if any desirable features, is converted into a laboratory. It is a hopeless task to later incorporate into such a building the desirable features as to adequate ventilation, light, suitable floors, and necessary safety installations. It would be in the interest of economy and plant efficiency to "start from scratch" and design a laboratory, giving to the design the careful thought of experienced laboratory men. Harry Vinock has presented some very excellent suggestions to those

who would design an efficient routine or semi-routine refinery laboratory.[6]

Use of Women in Refinery Laboratories

The success with which women have been trained to step into responsible refinery positions, thus replacing men taken into the armed services and relieving technically trained chemists and engineers of minor routine duties, is an accomplishment of which the industry is deservedly proud.[7,8,9,10,11] Without their help, the industry's contribution to the conduct of the war would have been very much retarded. There are yet many places where women may be used in refinery work to relieve technical men for work of an investigational nature. The training of chemists in job instructor training methods[12,13] is the first step to take in a program designed to supplement the technical staff with women workers.



It is also advisable for the supervisory group to study the local labor laws concerning the employment of women. This group should also become familiar with specific problems inherent in women-labor problems. Although fundamental principles of supervision of both men and women are the same, certain aspects of the matter are vastly different. The subject is being given consideration in various supervisory publications.

Atmosphere of Friendly Service

Fitzgerald has prepared a comprehensive analysis of the factors which cause poor relations to exist between refinery departments.[14] In spite of the inherent nature of certain laboratory duties, which have a tendency to keep it at odds with other departments, the laboratory has a splendid opportunity to lead the way in promoting good will and cooperation between departments. This requires tact and diplomacy of the personnel particularly on the part of the chief chemist and his assistant. With an understanding of the many circumstances which cause unpleasant departmental relations[14] the laboratory through the application of practical psychology, can head off many of the causes of friction and thus prevent resulting inefficiencies. It cannot be denied that many unfortunate misunderstandings arise between other departments and the laboratory because of the unmannerly, or undiplomatic conduct of laboratory personnel. It is human nature for a foreman to resent the set back which the laboratory occasionally seems to impose upon his department. This resentment can be avoided, at least minimized, by the chief chemist or his assistant, if he sincerely appreciates all the circumstances and handles the matter in a tactful manner. Practically all causes of such misunderstandings arise from two real or imagined laboratory faults—slowness in obtaining needed information, or inaccuracy. The best guard against such misunderstandings is set out in a simple formula for efficiency:

"Speed + accuracy = efficiency."

This formula will not satisfy the chronic fault finder, but through constant endeavor on the part of everyone in the laboratory organization to do his or her work as quickly and as accurately as humanly possible, a reputation will follow which automatically counteracts unjustified fault-finding. Such a reputation, it is true, rarely exists, but nevertheless, it should be the desire of the laboratory supervision to strive for such a reputation.

The chief objective in refinery operations is to get finished products on their way to the consumer. The role of the laboratory is to assist all departments in achieving this goal as accurately and at the lowest possible cost. If the laboratory is to avoid the reputation of being a bottleneck in the refineries objective, it must have the support of refinery management. It must be managed by people qualified as technicians, foremen, and diplomats. Its technicians must be qualified not only by formal education but also by training and experience, gained through a preconceived plan of training. They should be given the treatment any professional man has a right to expect. They should be furnished with sufficient non-technical help capable, through training, of relieving them of routine and non-technical details. They should be furnished with a clean, orderly, well designed laboratory and plenty of up-to-date scientific tools. Its people should all reflect a sincere desire to be of service. These are the requirements of a laboratory which desires to play its role in refinery efficiency.

BIBLIOGRAPHY

[1] Fitzgerald, George F., "Materials Control in the Laboratory." Refiner and Gasoline Manufacturer, November 1934, Vol. 16, No. 11.

[2] Whitmore, F. C., "Occupational Deferment———" Chemical and Engineering News Insert, March 25, 1944, Vol. 22, No. 6, pp. facing 446.

[3] Billings, Erle M., "Where Are The Future Chemists?" Chemical and Engineering News, August 25, 1944, Vol. 22, No. 16, pp. 1357.

[4] Anonymous, "Getting and Keeping Technical Talent Today and in 40X." Modern Industry, May 15, 1944, pp. 42.

[5] Fraser, Andrew, Jr., "Professional Workers in War and Peace." Chemical and Engineering News, August 25, 1944, Vol. 22, No. 16, pp. 1379.

[6] Vinock, Harry, "Design of Routine and Semi-Routine Refinery Laboratories." Refiner and Natural Gasoline Manufacturer, March 1936, Vol. 15, No. 3, pp. 114.

[7] Anonymous, "How Continental Oil Company Trains Women Workers." The Oil and Gas Journal, June 17, 1943, Vol. 42, No. 6, pp. 36.

[8] Anonymous, "How Standard of California is Meeting the Manpower Problem." The Oil and Gas Journal, June 24, 1943, Vol. 42, No. 7, pp. 82.

[9] Anonymous, "They Fill Plant and Warehouse Jobs of Men Gone to War." National Petroleum News, March 3, 1943, Vol. 35, No. 9, pp. R-101.

[10] Anonymous, "Gulf Pleased With Efficiency of Women Employees." Oil and Gas Journal, December 16, 1943, Vol. 42, No. 32, pp. 36.

[11] Anonymous, "More Than 1000 Women Employed at Continental Refinery." Oil and Gas Journal, September 9, 1944, Vol. 43, No. 18, pp. 91.

[12] Job Instructors Reference Material, "Training Within Industry." The Bureau of Training, War Manpower Commission, May 1944.

[13] Bundey, R. E., "Hoy to Teach a Job." Published by National Foreman's Institute, Chicago, Illinois.

[14] Fitzgerald, George F., "Relations Between Refinery Departments and The Laboratory." Refiner and Natural Gasoline Manufacturer, February 1937, Vol. 16, No. 2, pp. 81.

PART 3

L. K. SPINK

The Foxboro Company, Foxboro, Massachusetts

A DISCUSSION of Conditions Affecting the Operation of the Differential Type Flow Meter would not be complete without consideration of the subject of installation.

Because of space limitations, the following discussions of specific problem solutions are abbreviated. Deviation from any of the specifications given in the drawings may result in unsatisfactory operation, even though the reason is not covered in the text. Purge systems and seal systems must work with, and not against, the force of gravity or buoyancy; and protection against sudden displacement of line fluid into the piping must be provided, by the use of volume chambers or the equivalent.

Characteristics of the Differential Type Flow Meter and Conditions Affecting Its Operation

Installation

FOR correct flow measurement, the differential recorder or indicator should measure the same as if located at the level of the pressure taps. If the material filling the upstream pressure connection is of the same density as that filling the downstream pressure connection to the instrument, the readings will be the same regardless of the location of the instrument.

Based on the analysis of thousands of service reports, one of the major sources of difficulty in steam- or liquid-flow measurement arises from non-continuity of the liquid filling the piping. The false assumption that liquid in any system will find the lowest level is the source of more trouble in flow measurement than any other single factor.

The presence of air, gas, or vapor in the piping at a point where it does not interfere with the continuity of the liquid used to fill the piping does not prevent accurate flow measurement. Vapor traps located at each high point in the piping system where they will trap the air, gas, or vapor where it will not interfere with the continuity of the liquid filling the piping, will permit accurate measurement. The relative level of these vapor traps is not important. The pressure at any point in a solid-liquid-filled system is equal to the pressure at the starting point plus or minus the vertical head times the density of the filling liquid, and the amount added or subtracted is the same on the upstream side of the orifice on the downstream side, as long as the piping is filled with a liquid of the same density. Any interruption of this solid head, however, results in an error equal to the height of the bubble of gas or vapor times the density of the medium filling the piping.

One of the most common reasons for entrapment of air or vapor is the use of needle-valve shut-offs. The normal position for installation of such a valve is with the line pressure under the seat, so as to permit repacking the valve while the line is under pressure. This forces the air or vapor, in order to escape into the flow line, to pass vertically downwards through the seat. Obviously, as long as there is liquid under the seat at a pressure greater than that of the pressure within the piping system, the gas or vapor will not flow in this direction. Pressure in the system can only be increased by liquid flowing upward through the seat of the valve compressing the air in the system, and when a point of balance is reached, flow ceases and the gas or vapor remains in the system, unless there is a change in differential or static pressure. (See Figure 18). Eventually, on a system on which the static pressure or differential is fluctuating, the gas or vapor in such piping will be eliminated, but on steady flows and steady pressures it will remain indefinitely.

If the fluid used to fill the piping is volatile, the vapors may be replenished faster than they are eliminated. On such installations it is important to use gate or other full-opening type valves and to install the instrument directly below the orifice. Even though the liquid used to fill the piping boils at or near atmospheric temperature under line pressure, by proper arrangement for the disposal of the vapors and by insulation of the lead lines, satisfactory measurement may be obtained. The vaporization of the liquid in the piping causes a refrigeration effect which eventually reduces the temperature to a point below boiling. If the boiling material is a combination of materials of different boiling points, the evaporation eventually raises the boiling point of the material in the piping system and this, together with the reduction in temperature, reduces vaporization to a negligible amount.

With proper piping precautions and with a non-

volatile filling fluid in the piping lines, it is perfectly feasible to locate the meter at 500, 1000 or more feet from the orifice. However, usually physical limitations which interfere with the proper sloping of the piping make such long-distance installations impractical. In the modern installation, pneumatic transmission eliminates the danger involved in running high-temperature piping connections inside the control room and the complication of maintaining proper slopes over roads, walks, stairways, traveling cranes, etc. It is well to remember, however, that most cases of condemnation of direct-connected meters have resulted from an inadequate understanding of the possibility of entrapment of vapors.

If, however, the meter is located above the line, and if the line drops at times to atmospheric pressure or below, or if the meter is operating under vacuum, then the difficulties of operating a liquid-filled system become extreme. Venting a vapor trap will mean admitting air into the system, if the pressure is below atmospheric. Liquid-filled systems have been operated at pressures as low as 40 millimeters of mercury, absolute, but at these conditions extra precautions against leakage must be taken, since each cubic foot of air expands to approximately 20 cubic feet at this reduced pressure. At such low pressures, even stable filling fluids give off a certain amount of air which they have absorbed at atmospheric pressure. At 0.34-inch of mercury absolute pressure, water boils at 60° F.

In liquid-flow-meter piping, the principal problems are: prevention of vaporization, prevention of corrosive effects reaching the meter, prevention of plugging or congealing in the lead lines, and prevention of freezing in the lead lines. Vaporization and corrosion usually are prevented by the use of liquid seals or liquid purges. The seal liquid preferably should be heavier than the flowing liquid and must be nonmiscible with it. For oils and oily liquids, anti-freeze mixtures of Prestone and water or glycerine and water are most commonly used.

The seal piping system should be equipped with large volume chambers or seal pots to reduce the displacement of the sealing liquid. By-pass lines should be provided both above and below the level of the seal liquid, to permit equalizing of the sealing liquid when the flange valves are closed. Opening of any of the by-pass valves below the level of the sealing liquid without closing one or the other of the flange valves when the liquid is passing through the orifice will result in blowing the seal liquid.

A continuous purge frequently is used to eliminate volatile liquids, corrosive fluids, or those containing sediment which would plug the piping from the piping system. If this flow is kept low enough so that it does not create a readable pressure drop, it will not affect the flow-meter readings. Frequently a by-pass valve is placed around the purging restriction to permit giving the piping a blast of purging liquid in case plugging should start. When a purging liquid under sufficient pressure to overcome the line pressure is unavailable, a small pump such as a lubricator pump may be used.

Freezing in steam-meter leads located out-of-doors

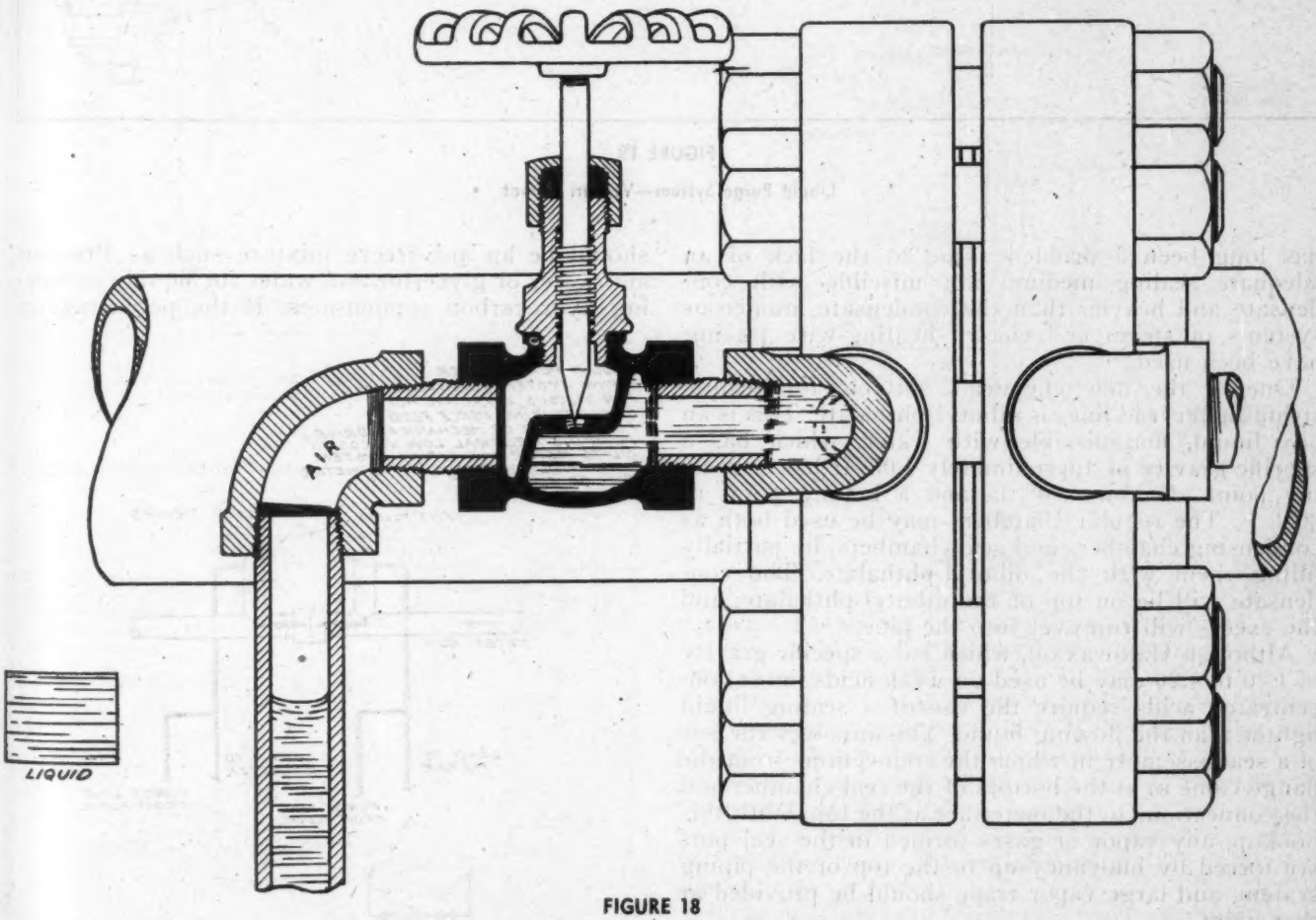


FIGURE 18

Air Trapped by Needle Valve

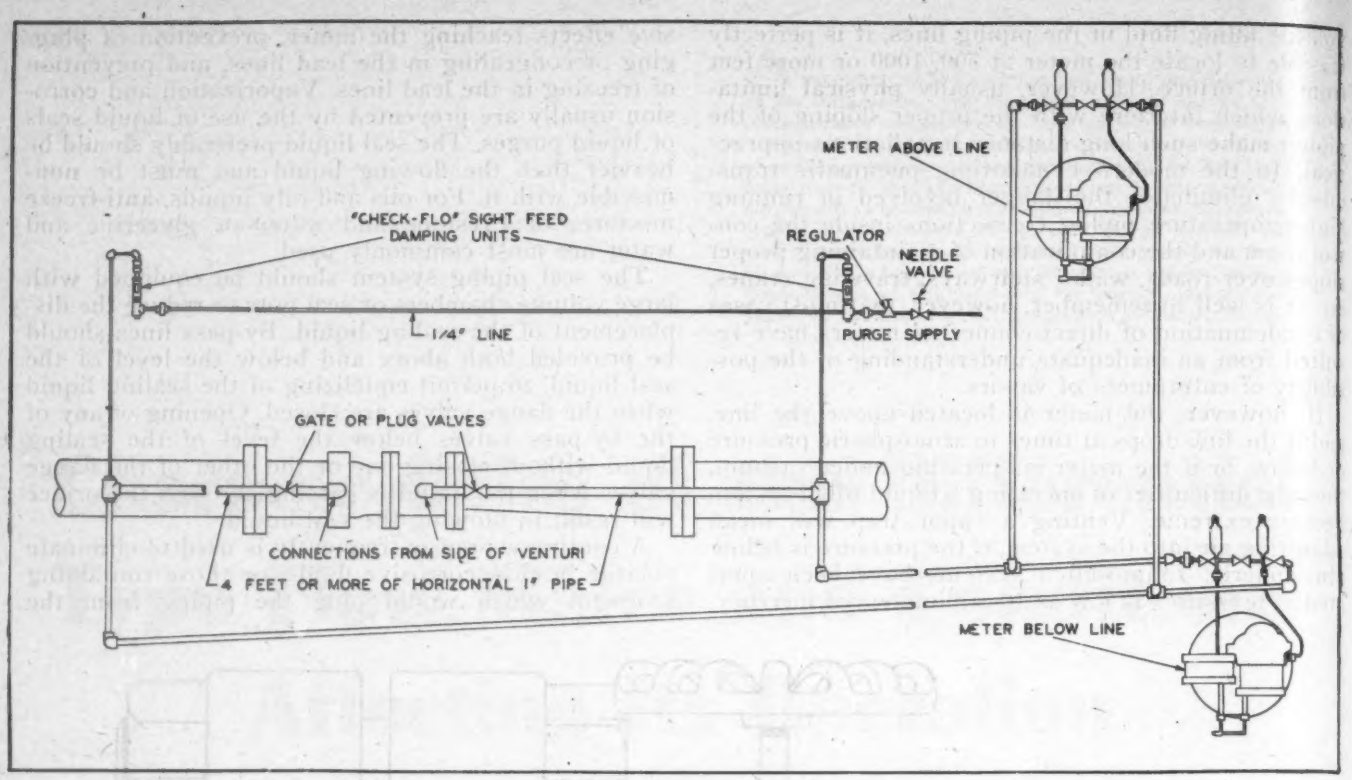


FIGURE 19

Liquid Purge System—Venturi Throat

has long been a problem. Due to the lack of an adequate sealing medium not miscible with condensate and heavier than the condensate, numerous systems of steam and electric-heating-wire tracing have been used.

One of the new chemicals suitable for sealing steam-meter lead lines is dibutyl-phthalate. This is an oily liquid, non-miscible with water, which has a specific gravity of approximately 1.05. It has a freezing point of minus 30° F. and a boiling point of 600° F. The regular chambers may be used both as condensing chambers and seal chambers, by partially filling them with the dibutyl-phthalate. The condensate will lie on top of the dibutyl-phthalate, and the excess will run over into the pipe.

Although Halowax oil, which has a specific gravity of 1.20 to 1.26 may be used on weak acids, most concentrated acids require the use of a sealing liquid lighter than the flowing liquid. This involves the use of a seal assembly in which the connections from the flange come in at the bottom of the seal chamber and the connections to the meter are at the top. With this hookup, any vapor or gases formed in the seal pots are forced by buoyancy up to the top of the piping system, and large vapor traps should be provided at that point.

On liquid-meter installations, if the pressure connections are faced out horizontally, the possibility of getting vapor or sediment into the piping leads is minimized. If the presence of vapor is suspected, the orifice should be placed in a vertical line with the flow in an upward direction. If the quantities of vapor are small, they may be handled by a small drain hole in the orifice plate flush with the top of the line. They should not be allowed to dam up behind the orifice.

For handling gases containing large percentages of condensate, liquid seals may be necesary. These should be an anti-freeze mixture such as Prestone and water or glycerine and water for liquids containing hydrocarbon condensates. If the percentage of

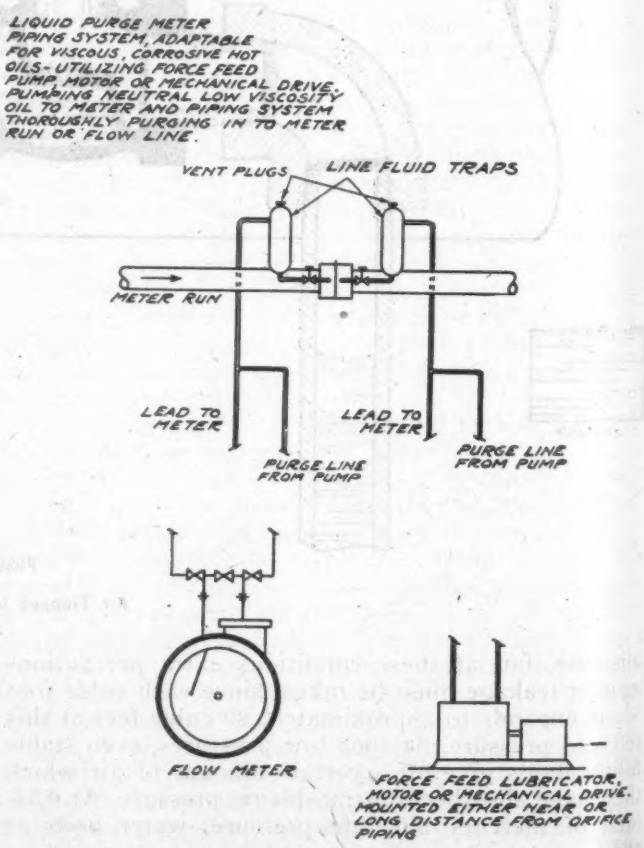
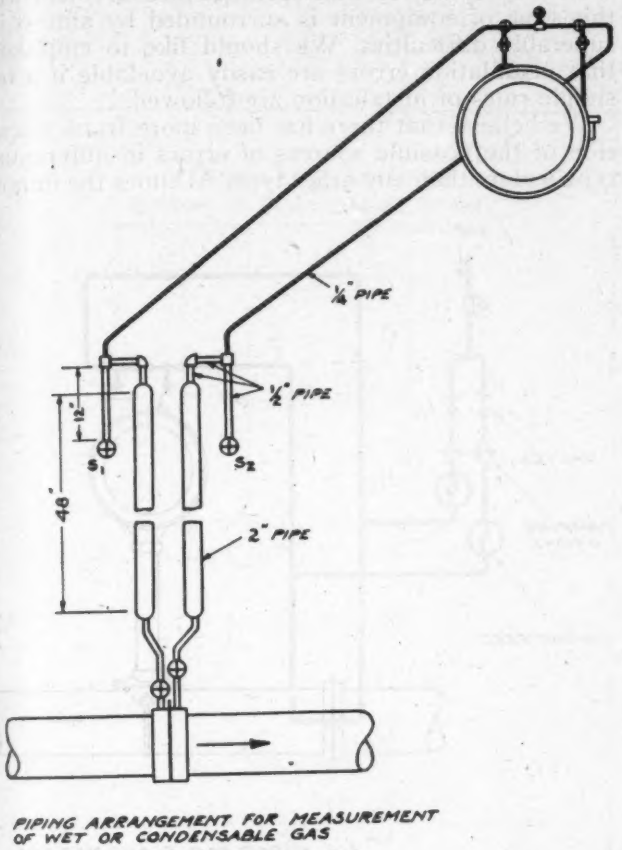

LIQUID PURGE METER
PIPING SYSTEM, ADAPTABLE
FOR VISCOUS, CORROSIVE HOT
OILS - UTILIZING FORCE FEED
PUMP, MOTOR OR MECHANICAL DRIVE,
PUMPING NEUTRAL LOW VISCOSITY
OIL TO METER AND PIPING SYSTEM
THOROUGHLY PURGING IN TO METER
RUN OR FLOW LINE.
VENT PLUGS
LINE FLUID TRAPS
METER RUN
LEAD TO METER
LEAD TO METER
PURGE LINE FROM PUMP
PURGE LINE FROM PUMP
FLOW METER
FORCE FEED LUBRICATOR, MOTOR OR MECHANICAL DRIVE. MOUNTED EITHER NEAR OR LONG DISTANCE FROM ORIFICE PIPING

FIGURE 20

Liquid Purge Meter Piping System

condensates is small, they may be eliminated by the use of an atmospheric condensing chamber such as shown in Figure 21 which permits the condensable vapors to come to atmospheric temperature, drop out, and gravitate back into the flow line.

Hydrogen sulphide in a natural gas or refinery gas should be prevented from entering the meter piping



PIPING ARRANGEMENT FOR MEASUREMENT OF WET OR CONDENSABLE GAS

FIGURE 21

Piping Arrangement for Measurement of Wet or Condensable Gas

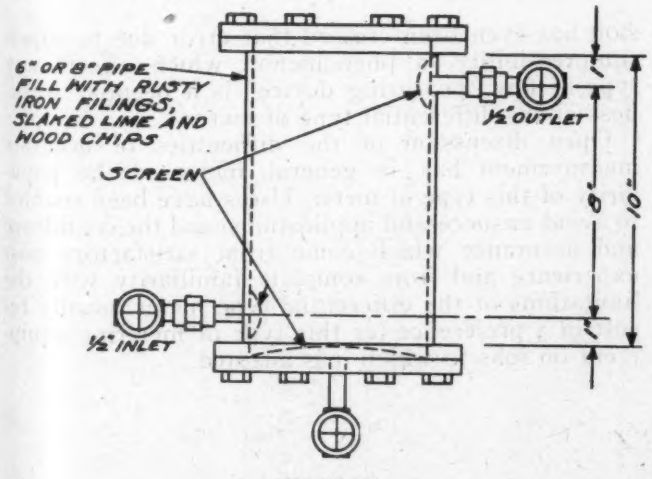


FIGURE 22

Gas Purifier

by insertion of a gas purifier chamber such as illustrated in Figure 22 in each lead line between the primary device and the instrument. The contents of one of these chambers will remain active for a long time because there is no circulation through the meter. The purifying chamber has no work to do except when there is a change in pressure or a change in rate of flow.

To protect an instrument from the effects of hydrogen sulphide, construct a chamber as illustrated in Figure 22. Completely fill with a mixture of even parts: first—rusty iron filings or shavings; second—unslaked lime; third—wood chips. Connect the lower or inlet pipe to the line, as close as possible to it. Pipe from the outlet or upper connection to the instrument. This purifier will absorb the H_2S and prevent it from reaching the instrument. The contents should be renewed periodically at intervals depending on the service. Usually one filling will serve for six months. The iron filings can be revivified by spreading out in the sunlight in open air.

Corrosive vapors such as chlorine, acetic acid, and hydrochloric acid should be purged from the meter and meter piping by inert gas. The usual piping hookup is shown in Figure 23. Some of the purge accessories may be eliminated if the flows and pressures are constant. When using a bottled gas as

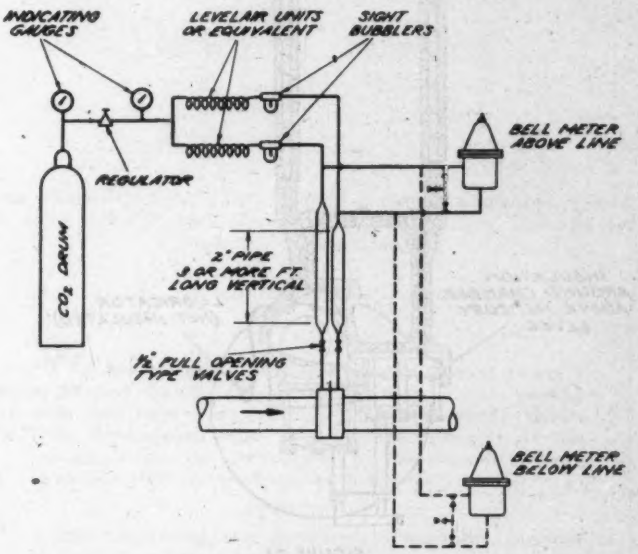


FIGURE 23

Chlorine Flow Meter

a purging medium, the flows may be reduced to as little as 1/10 of a cubic foot per hour by use of a long capillary restriction.

Hydrogen sulphide, if dry, is not corrosive to any of the ordinary structural parts of the flow meter and may be measured without seals or purges.

Phenol is a liquid which congeals at atmospheric temperatures, but is not injurious to the internal parts of a flow meter. It may be measured satisfactorily by steam tracing the meter lead lines and meter body.

If the pressures are reasonably constant, liquid may be measured satisfactorily using gas or air to purge the meter body and piping. Molten sulphur is an example of an unusual liquid commonly measured in this manner.

For accurate measurement by the differential-type meter, the flow should not vary more than plus or minus 20 percent unless the fluctuations are slow enough to permit a readable record of the actual variations to be made. Pulsating liquid flows such as those of single-acting reciprocating pumps should be made uniform by the use of a cushion chamber between the source of the pulsation and the orifice. A

safe criterion for the design of the cushion chamber is a cushion volume sufficient that the instantaneous discharge of the volume of one cylinder should not raise the pressure sufficiently to increase the differential across the orifice by more than 40 percent.

On compressible fluids, the pulsation error may be minimized by the use of a high operating differential, a high ratio of orifice-to-pipe diameter, or by use of

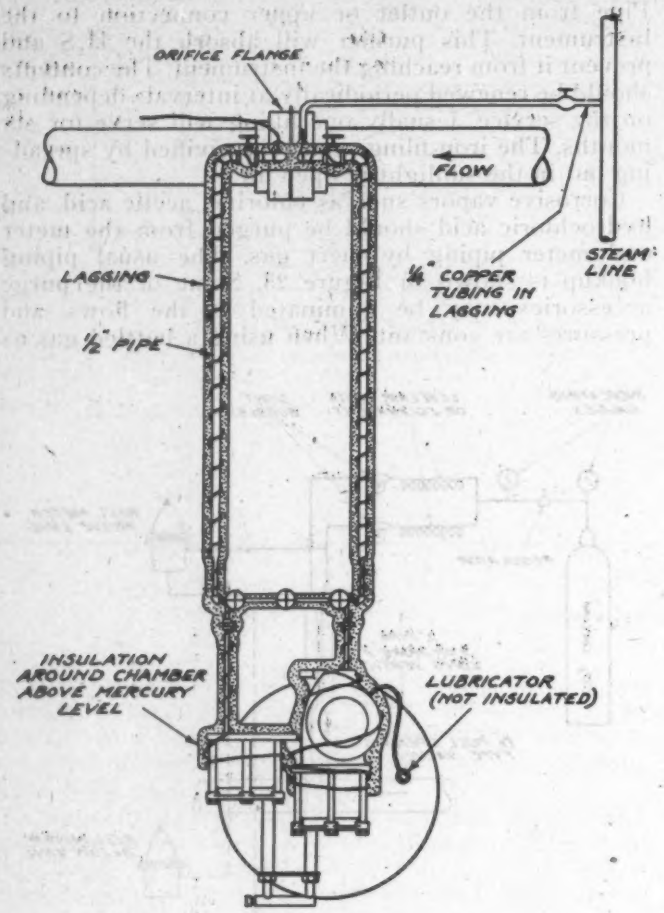


FIGURE 24

Insulation of Lead Lines on Flow Meters

capacity adjacent to the source of pulsation and resistance adjacent to the orifice. On gas compressors, pulsations are usually less serious on the suction side. Measurement at a point where the pressure has undergone a drop greater than 50 percent of the absolute pressure is usually free from the effects of pulsation.

In handling pulsating gas flows, restrictions or cushion chambers in the lead line to the differential instrument are worse than useless. A well-designed damping unit in the U-bend of a mercury float type instrument will give a readable and reasonably accurate reading if the differential fluctuations do not exceed 40 percent of the operating differential. If the fluctuations are greater than this, while the record may be readable, the readings will not be reliable.

Study of the possible errors in measurement by the differential-type flow meter may leave the reader with the impression that accurate measurement with this type of equipment is surrounded by almost insuperable difficulties. We should like to emphasize that installation errors are easily avoidable if a few simple rules of installation are followed.

We believe that there has been more frank discussion of the possible sources of errors in differential-type meters than any other type. At times the impression has even been created that error due to supercompressibility—a phenomenon which affects any type of flow measuring device—is a peculiar weakness of the differential type of meter.

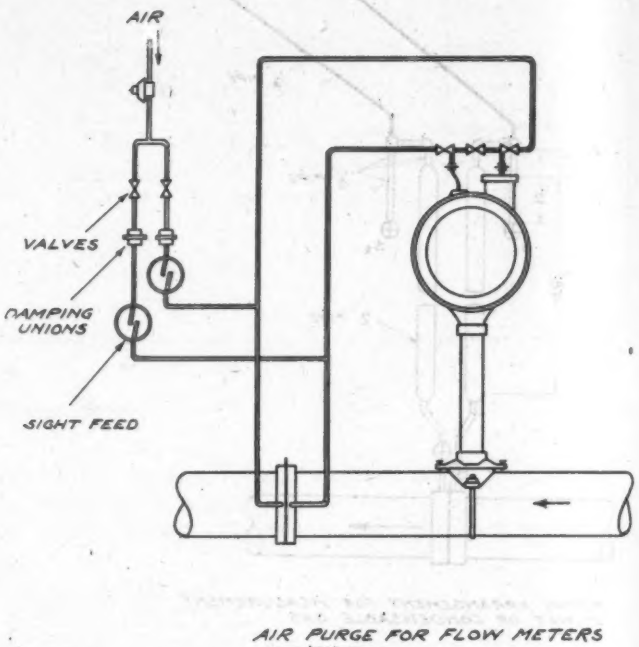


FIGURE 25

Air Purge for Flow Meters

Open discussion of the difficulties of accurate measurement has, in general, increased the popularity of this type of meter. Users have been enabled to avoid unsuccessful applications, and the confidence and assurance which come from satisfactory past experience and from complete familiarity with the limitations of the differential-type meter usually result in a preference for this type of metering equipment on jobs to which it is adapted.

Effect of the Diameter of Laboratory Columns With Fenske Packing on Their Efficiency and Capacity

B. A. KAZANSKII, A. L. LIBERMAN and O. D. STERLIGOV
Institute of Organic Chemistry, Academy of Sciences, U. S. S. R.

From Zhurnal Obshchei Khimii (Journal of General Chemistry), Volume 13, pages 125-130, 1943. Translated by J. G. Tolpin, Universal Oil Products Company, Chicago.

WITHIN the limits of diameter investigated (from 8 to 20 mm) the efficiency of fractionating columns packed with one turn glass helices (Fenske packing) shows little dependence upon the internal diameter of the column, while the throughput of the column greatly increases with increase of the diameter.

This translation was provided through the Division of Petroleum Chemistry, American Chemical Society.

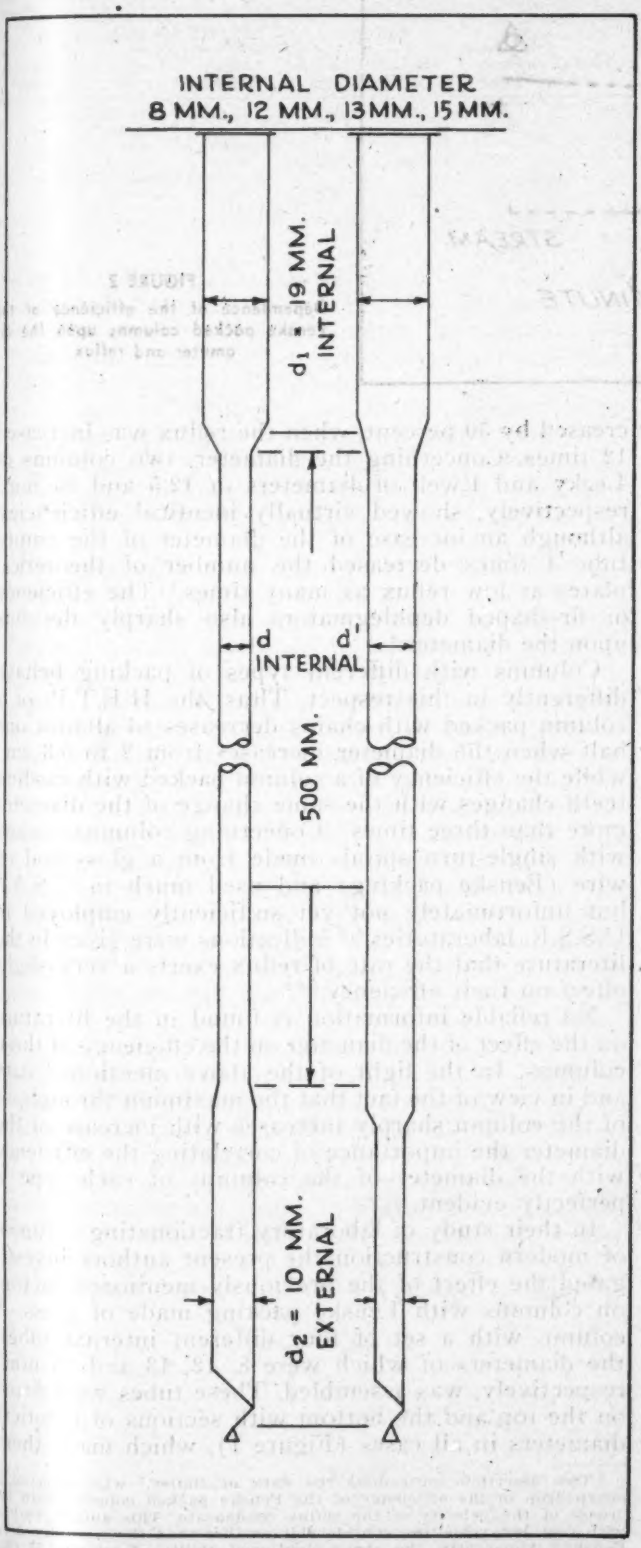


FIGURE 1
Interchangeable Tubes

IN THE design of laboratory distillation columns of different types the effect on their efficiency and maximum capacity of certain factors is to be reckoned with, such as diameter of the column and the velocity of the reflux condensate. It is known from the literature that both these factors can exert different influences on the columns, depending upon the construction of the latter. For instance, columns with Stedman packing[1] show an efficiency greatly depending upon the rate of reflux condensate. The curve expressing this dependence reveals a sharp maximum due to which the number of theoretical plates can change in the region of highest efficiency of the column 2.5-3 times, when the reflux is increased by 50-60 percent. Yet, the diameter of the columns of this type exerts little effect on the highest efficiency and on the position of the maximum, although the form of the latter is considerably changed.

In columns described by Lecky and Ewell[2] changes of the reflux velocity and of the diameter fail to influence the efficiency to any appreciable extent. In one case an increase of the reflux 15 times changed the number of theoretical plates of the column only by 1.5 percent; in another case the number of theoretical plates passed through a flat maximum and in-

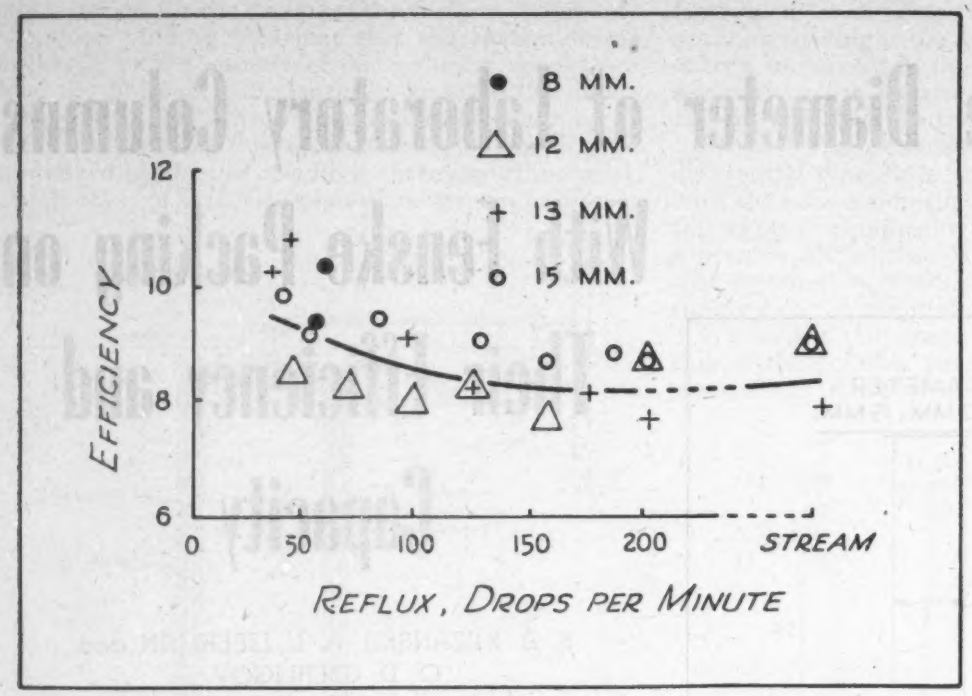


FIGURE 2
Dependence of the efficiency of the Fenske packed columns upon the diameter and reflux.

TABLE 1
Efficiency of the Column with 8 mm. Diameter

Experimental Number	Rate of Reflux, Drops per Minute	n(20/D)		Number of Theoretical Plates	H.E.T.P., cm.
		At the Top	In the Flask		
1	44	1.4756	1.4610	9.5	5.3
2	64	1.4755	1.4607	10.25	4.9
3	70	Flooded	Flooded	....	...

TABLE 2
Efficiency of the Column with 12 mm. Diameter

Experimental Number	Rate of Reflux, Drops per Minute	n(20/D)		Number of Theoretical Plates	H.E.T.P., cm.
		At the Top	In the Flask		
1	40	1.4741	1.4611	8.75	5.7
2	60	1.4733	1.4608	8.5	5.9
3	80	1.4725	1.4606	8.25	6.1
4	124	1.4720	1.4602	8.5	5.9
5	160	1.4718	1.4604	8.0	6.3
6	200	1.4714	1.4598	8.5	5.9
7	200	1.4713	1.4598	8.25	6.1
8	Almost a Stream	Flooded	Flooded	....	...

TABLE 3
Efficiency of the Column with 13 mm. Diameter

Experimental Number	Rate of Reflux, Drops per Minute	n(20/D)		Number of Theoretical Plates	H.E.T.P., cm.
		At the Top	In the Flask		
1	38	1.4762	1.4612	10.25	4.9
2	40	1.4764	1.4608	10.5	4.8
3	88	1.4739	1.4609	9.0	5.5
4	124	1.4733	1.4610	8.5	5.9
5	172	1.4720	1.4609	8.0	6.3
6	200	1.4715	1.4607	7.5	6.7
7	Stream	1.4713	1.4606	7.5	6.7

TABLE 4
Efficiency of the Column with 15 mm. Diameter

Experimental Number	Rate of Reflux, Drops per Minute	n(20/D)		Number of Theoretical Plates	H.E.T.P., cm.
		At the Top	In the Flask		
1	40	1.4748	1.4606	9.75	5.1
2	44	1.4741	1.4606	9.25	5.4
3	80	1.4740	1.4605	9.25	5.4
4	128	1.4732	1.4601	9.0	5.5
5	160	1.4727	1.4604	8.5	5.9
6	180	1.4723	1.4602	8.5	5.9
7	200	1.4718	1.4599	8.5	5.9
8	Stream	1.4716	1.4596	8.5	5.9

creased by 30 percent, when the reflux was increased 12 times. Concerning the diameter, two columns of Lecky and Ewell of diameters of 12.5 and 25 mm., respectively, showed virtually identical efficiencies, although an increase of the diameter of the empty tube 4 times decreased the number of theoretical plates at low reflux as many times.[1] The efficiency of fir-shaped dephlegmators also sharply depends upon the diameter.[3]

Columns with different types of packing behave differently in this respect. Thus, the H.E.T.P. of a column packed with chains decreases to almont one half when the diameter increases from 2 to 5.3 cm., while the efficiency of a column packed with carding teeth changes with the same change of the diameter more than three times.[3] Concerning columns packed with single-turn spirals made from a glass rod or wire (Fenske packing) and used much in U.S.A.,[4] but unfortunately not yet sufficiently employed in U.S.S.R. laboratories,[5,6] indications were given in the literature that the rate of reflux exerts a very slight effect on their efficiency.[3*]

No reliable information is found in the literature on the effect of the diameter on the efficiency of these columns. In the light of the above mentioned data and in view of the fact that the maximum throughput of the column sharply increases with increase of the diameter the importance of correlating the efficiency with the diameter of the columns of each type is perfectly evident.

In their study of laboratory fractionating columns of modern construction the present authors investigated the effect of the previously mentioned factors on columns with Fenske packing made of glass. A column with a set of four different internal tubes, the diameters of which were 8, 12, 13 and 15 mm., respectively, was assembled. These tubes were fitted on the top and the bottom with sections of identical diameters in all cases (Figure 1), which made them

* This assertion contradicts the data of Bailey,[7] who observed a sharp drop in the efficiency of the Fenske packed columns with increase of the velocity of the reflux condensate. This author worked with very low velocities, considerably smaller than those employed by Fenske.[3] Apparently, the above mentioned ability of columns of this type to preserve a more or less constant efficiency with change of the velocity of reflux is valid only at comparatively high velocities, from 1 ml. per minute up.

TABLE 5

Efficiency of 1.5 m. Column of Different Diameter

a) Diameter 11 mm. Height 140 cm. Refractive index of the mixture of benzene with dichloroethane n(20/D), 1.4509.

Experimental Number	RATE OF REFLUX		n(20/D)		Number of Theoretical Plates	H.E.T.P., cm.
	At the Top	At the Bottom	At the Top	In the Flask		
1.....	144	Difficult to count	1.4678	1.4488	22	6.3
2.....	350		1.4668	1.4506	16	8.7

b) Diameter 20 mm. Height 150 cm. Refractive index of the mixture of benzene with dichloroethane n(20/D), 1.4547.

Experimental Number	RATE OF REFLUX		n(20/D)		Number of Theoretical Plates	H.E.T.P., cm.
	At the Top	At the Bottom	At the Top	In the Flask		
1.....	Difficult to count	Stream	1.4689	1.4503	20.5	7.3
2.....	Stream	Continuous Stream	1.4726	1.4498	18.3	8.2
3.....	Continuous Stream	Continuous Stream	1.4705	1.4495	16.0	9.4

easily interchangeable. With the aid of a cork the column was attached to a Whitmore-Lux still head with a Svietoslawski drop counter. In addition, the column was fitted with a glass sleeve and a flask with a sampling device. No external heating was used for the sake of simplicity, and in this respect it differed from the columns described below. One-turn helices made of a glass rod with internal diameter 4.2 mm. and thickness of the rod of 1 mm. were used as packing and the height of the packed section was 50 cm.

The number of theoretical plates was determined as previously described.[6] A mixture of dichlorethane with benzene (refractive index of the mixture n(20/D), 1.4620) was used in all cases in amounts exceeding the volume of the working part of the column 1.5 times. The rate of reflux was estimated from the number of drops returned to the column from the counter on top of the still head per minute.

The results obtained in these tests are shown in Tables 1-4 and in Figure 2. The effect of the diameter on the throughput of this column is easily seen. The tube with diameter 8 mm. was flooded already at a reflux velocity of 70 drops per minute, while the 15 mm. diameter column performed normally even when a continuous stream was passed from the counter. The rate of condensate within the limits investigated affected the efficiency of these columns only to a very small extent, and the number of theoretical plates of the column diminished by only 30 to 40 percent when the rate of reflux increased 5 times. With further increase of the reflux up to formation of a continuous stream the efficiency within the limits of experimental error showed no change.

The most interesting conclusion is thought to be that indicated by the graph in Figure 2, showing the results of all tests. It is evident from this graph that the efficiency of columns of the type under investigation does not depend upon the diameter within the limit of experimental error, at least within the limits studied. In order to test this conclusion a second column was constructed (column No. 2) similar to that previously described[6] and termed here column No. 1; the only difference consisted in that the newly constructed column had an internal diameter of 20 mm., instead of 11 mm. of the previously used column.

The new column consisted of a glass tube with internal diameter 11 mm. and fused to it was a Whitmore-Lux still head with a drop counter and a glass sleeve.

The sleeve was coated with an insulating asbestos layer 3-4 mm. thick, on which an electrical heating wire spiral was wound. On top of the spiral a second layer of asbestos was placed, 25-30 mm. thick. In this column Fenske packing was also used and it formed three sections 45 cm. each. The two layers separating these three sections were made of pieces of glass tubing, 5 x 5 mm. in size, each separating layer being 2.5 cm. thick. Thus, the total length of the working part of the column was 140 cm. As previously stated,[6] the use of these separating layers is very advantageous, since it increases the efficiency of the column.

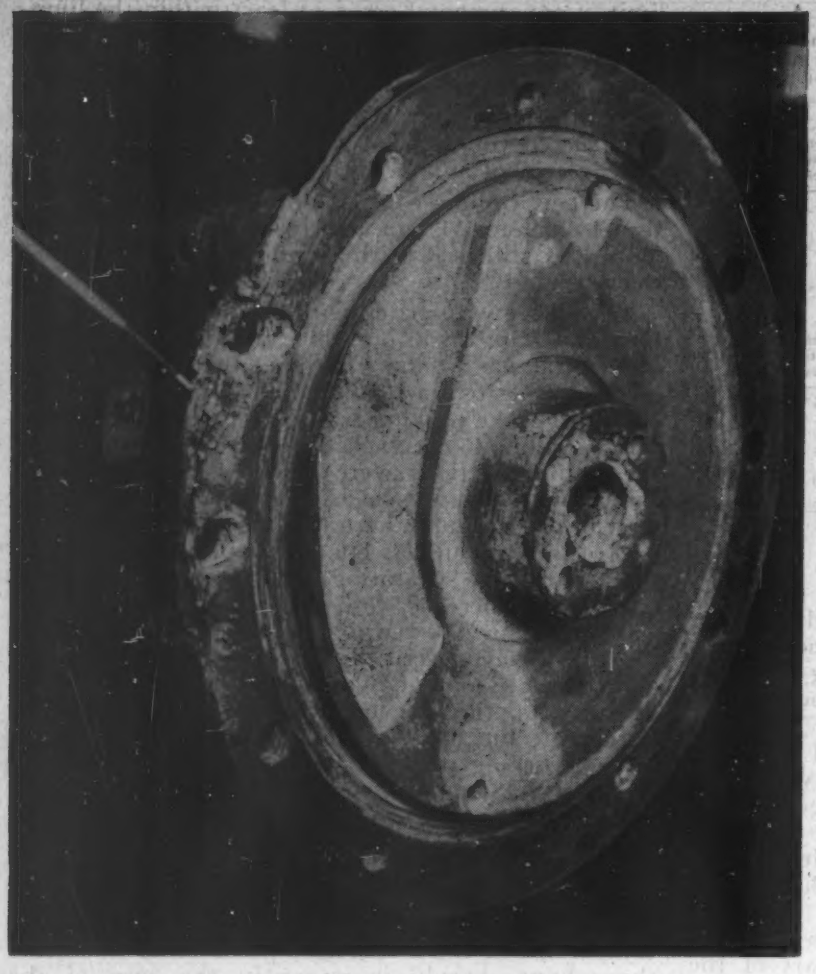
The column No. 2 was made in the same way as the previously described, only the inside tube was substituted by one of 20 mm. internad diameter. The other parts, the sleeve, heating arrangement, still head, were the same as in column No. 1, The length of the working part was brought to 150 cm., three sections of 48 cm. each separated, as in the previous case, with layers of 3 cm. each.

The results of comparing the efficiencies of these columns are shown in Table 5. Doubling of the diameter leaves the efficiency of the column unaffected within the limits of experimental error, as shown by comparison of the H.E.T.P. On the other hand, the throughput sharply increases in the case of the larger diameter. The column No. 1 was flooded at a distillation rate of about 300 ml. per hour (when the sampling valve at the still head was fully opened), while in the column No. 2 distillation could be carried out at a rate exceeding 650 ml. per hour without any difficulty. Generally speaking, it is very difficult to reach flooding conditions in this column.

The above stated facts point to the conclusion that an increase of the diameter of the columns of this type may lead to fractionating equipment of large throughput and sufficiently high efficiency. In principle, this points to possible employment of these columns in industry.

REFERENCES

[1] L. B. Bragg, Refiner **20**, No. 2, 73, 1941.
[2] H. S. Lecky and R. H. Ewell, Ind. Eng. Chem., Anal. Ed. **12**, 544, 1940.
[3] M. R. Fenske, C. O. Tongberg and D. Quiggle, Ind. Eng. Chem. **26**, 1169, 1934.
[4] A. E. Morton, Laboratory Technique in Organic Chemistry, Khimizdat, 1940, chap. 9 (Russ.).
[5] B. A. Kazanskii, M. I. Rozengart and O. P. Solovova, Izvestiya Akademii Nauk S.S.S.R., Otdelenie Khimicheskikh Nauk (Bull. Acad. Sci. URSS, Classe Sci. Chim.) **1941**, 97—Survey For. Petrol. Liter. 365A.
[6] B. A. Kazanskii, A. L. Liberman, S. R. Sergienko, G. A. Tarasova and A. F. Plate, Zhurnal Obshchei Khimii (J. Gen. Chem.) **12**, 112, 1942—Survey For. Petrol. Liter. 399.
[7] A. J. Bailey, Ind. Eng. Chem. Anal. Ed. **13**, 487, 1941.



Pump Salvage Job

J. BARRIE GRAHAM, Metal Inspector
Standard Oil Company of Ohio,
Toledo Refinery

(Photos by O. H. Livingston)

FIGURE 1

IN common with all Sohioans, the men and women at Toledo Refinery are interested in maintaining maximum war production of vital petroleum products. Since Toledo Refinery is the only refinery in Ohio producing finished 100-octane aviation gasoline, Toledo employes feel a special responsibility to the members of our armed forces and those of our Allies. All employes have willingly done their part, and more, but because of material shortages and more severe use of the equipment, the Mechanical Department has been especially hard pressed.

Both workmen and foremen in this department have accepted this challenge and have been successful in overcoming a number of difficult or unusual maintenance problems. This has been especially evident in the salvage program where many pieces of equipment, that several years ago would have been considered as useless, have now been repaired and returned to service.

An example of the work done by the Mechanical Department may be shown by the repair job recently performed on the JA-3 pump at the alkylation plant. This pump is used in the reactor recirculating system and is required to pump approximately 1580 barrels per day of 90-93 percent sulphuric acid at a temperature of 40-50° F. The suction pressure is 15 pounds per square inch and the discharge 20 pounds. The pump is a constant displacement rotary type driven by a 7½-horsepower motor, at 1135 revolutions per minute.

Recently the machine shop received a call to repair the packing gland on JA-3 pump but when S. P. Gerlach, the machinist on the job inspected the pump, he found both end shell covers were corroded to such an extent that renewal of both covers was necessary. Since obtaining new covers would mean a delay of from six months to a year, B. E. Henry, master mechanic, decided that it would be advisable to fabricate new ones in our own machine shop. Gerlach was given the job and he developed the new pieces which have proved to be entirely satisfatcory.

Figure 1 shows the corrosion around the stuffing box of the original end plate, which of course permitted excessive leakage through the packing. Both end plates were corroded in a similar manner.

In making up the new pieces, the cover plate, with both inside and outside bosses, was machined from heavy boiler plate. A hole was bored through the center of this piece, the diameter of the hole being slightly less than the finished shaft diameter. The bearing housing was then machined on the outside and a small hole drilled through the center. These two pieces were held in their relative positions by means of a special arbor while the support brackets were welded to both pieces.

This assembly was chucked in the lathe and the inside surface of the plate machines.

While the piece was still in this position in the lathe, both the stuffing box and the bearing housing were machined to final dimensions.

Both covers were made in this manner and are identical except that the inboard bearing housing is tapped out to accommodate the inner and the outer thrust-bearing adjusting nuts.

The shaft in the original pump was also badly worn so a new shaft was made by turning down a

FIGURE 2

larger worn shaft that had been removed from a reciprocating pump.

In Figure 2 is shown the new and the old end shell covers from the inboard side of the pump. This picture also shows the method of attaching the lugs for the packing-gland bolts.

In Figure 3 the pump is shown assembled and ready for installation at the alkylation plant.

Its performance after installation proved to be equal in every way to the performance of the original pump.

This ingenious repair job is but one of the many salvage jobs being performed at Toledo Refinery in these days of urgent production and restricted replacement parts, in order to keep the production of petroleum products for our armed forces at the maximum possible output.

The work was supervised by O. H. Livingston, machine shop foreman, who also took the pictures.

Boilermaker work was done by J. R. Mihalko and C. I. Phillips and the welding by I. L. Gillespie.

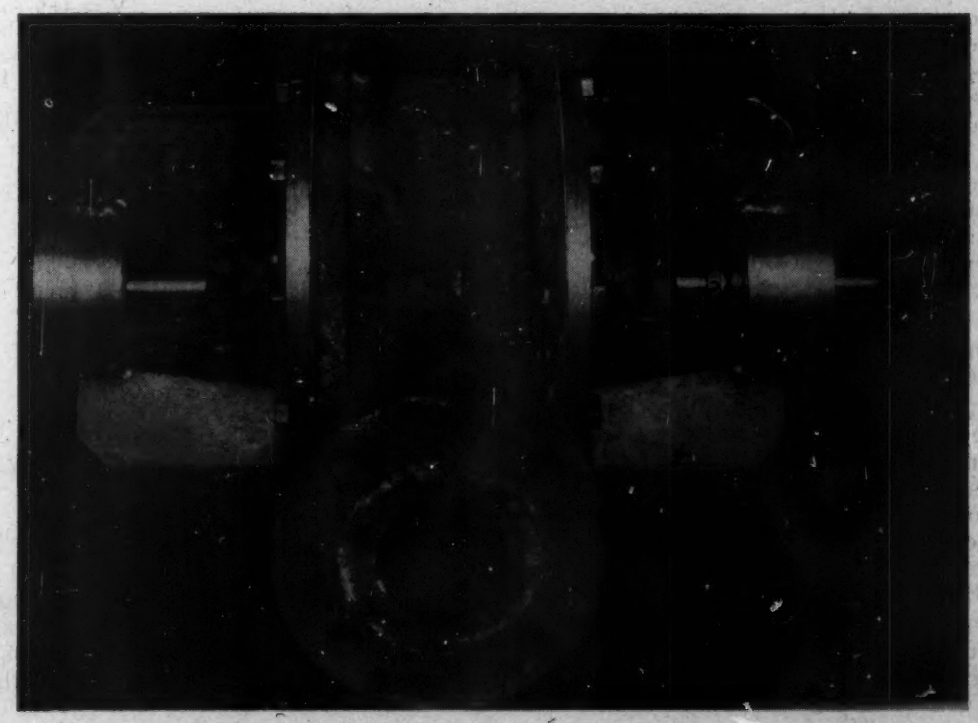


FIGURE 3

Application of Unit Operations to

Fractionation and Other Vaporization Processes

PART 11

Fractionation of Multi-Component Mixtures and Application of McCabe-Thiele Diagram to Complex Mixtures

R. L. Huntington
University of Oklahoma

A HIGH percentage of the fractionators in the petroleum industry process mixtures of hydrocarbons which contain three or more compounds. The calculation of the number of theoretical trays required for the processing of these more complex mixtures cannot be carried out rigorously by means of the McCabe-Thiele[16, 18] binary component diagram. Through the selection, however, of two key components in a complex mixture a fair approximation can be made of the plate requirements for a fractionating tower by this simple two-component diagram. In this analysis,[10] the author has taken the fraction of a gasoline boiling in the kerosine range as the less volatile component of the binary mixture, and the gasoline fraction of the kerosine as the more volatile component. By applying this method to the performance of a 3-foot x 90-foot bubble-plate tower, it was found that the fractionation efficiency in the 10-plate gasoline-kerosine section was 90 percent of the theoretical.

In the case of a four component mixture such as:

	mol %
Propane	25
N butane	25
N pentane	25
N hexane	25

two key components such as normal butane and normal pentane might be selected if the propane and normal butane are to be taken off overhead, since the propane would have very little tendency to go to the bottom of the tower, and vice versa for normal hexane. In other words this real "hammering" process would call for the elimination of normal pentane from the overhead and normal butane from the bottoms.

In the same way, a three-component mixture might be handled through the selection of two hydrocarbons as key components, such as

	mol %
Propane	33⅓
N butane	33⅓
N pentane	33⅓

the key components being propane and normal butane if propane is to be the overhead product.

Calculations by the algebra route are rather tedious, since each theoretical tray requires an equilibrium determination between the vapor and liquid as well as a material balance around the tray for the composition of the vapor rising from the next tray below. A better understanding of the details of this method can be obtained by going through the actual slide-rule operations.

A mixture of hydrocarbons consisting of an equal number of mols each of propane, normal butane and normal pentane is to be fractionated in a well-insulated column. A natural gasoline having a composition of (40 mol percent n butane and 60 mol percent n pentane) is desired; however, it is realized that a small amount of propane will be left in the bottoms. It is therefore assumed that the composition of the bottoms will be:

	mol %
Propane	0.50
N butane	39.50
N pentane	60.00

Likewise it is reasonable to assume that 0.5 mol percent of pentane will be left in the overhead product. A material balance for normal pentane on the basis of 100 mols of feed may now be made:

Basis 100 mols of Feed

Feed = Overhead Product + Bottoms

Pentane .333 (100) = .005 (V) + .60 (100—V)

33.33 = .005 (V) + 60—.60V

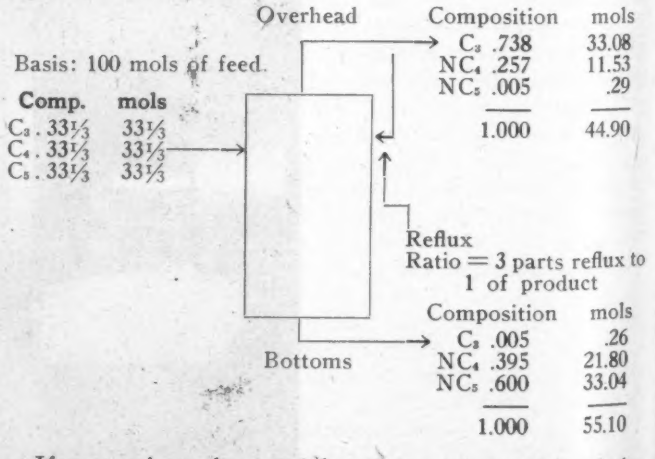
Solving above equation

—26.67 = —.595 V

V = 44.9 (overhead product) in mols.

100—V = 55.1 (bottoms) in mols.

The overall balance for the column may be shown:



If water is to be used for the condensation of the overhead product, it is assumed that the condensate will leave the water-cooled exchanger at 100° F. Neglecting friction loss through the vapor line, pressure in the top of the tower will be equivalent

to the vapor pressure of the condensate, which is calculated from Raoult's law as follows:

	mol fraction		Vapor Pressure		Partial Pressure lbs. per sq. in. abs.
C_3	.738	×	188	=	139.00
NC_4	.257	×	53	=	13.60
NC_5	.005	×	16	=	.08
Overhead (Total Vapor Pressure)					152.68

Plate-to-Plate Calculations Based on Vapor Pressure Data

The next step is to determine the composition and temperature of the liquid on the top tray of the tower. This calls for an equilibrium calculation involving the trial-and-error method. A temperature of 120° F. is assumed as a first approximation since the liquid on the tray must be warmer than that of the overhead condensate in order to drive the vapor in that direction.

Based on Raoult's law, the liquid composition is calculated, and if the sum of its component fractions equals unity, the correct temperature has been selected. The calculation is as follows:

1st Trial—120° F.

	Total Pressure π	×	mol Fr. in Vapor y	=	Vapor Pressure p	×	mol Fr. in Liquid x
C_3	152.68		.738	=	245		.461
C_4	152.68		.257	=	72.5		.542
C_5	152.68		.005	=	22.5		.034
							1.037

2nd Trial—Assume temperature of top tray = 125° F.

	π	y	=	p	x
C_3	152.68	.738	=	256.0	.440
C_4	152.68	.257	=	78.0	.502
C_5	152.68	.005	=	24.5	.031
					.973

By interpolation, it is seen that 122° F. would be the approximate temperature, and the approximate composition of the liquid on the top tray:

C_3 = .449 (mol. fraction)
C_4 = .519 (mol. fraction)
C_5 = .032 (mol. fraction)
1.000

The composition of the vapor rising into the top tray is obtained through a material balance. If a reflux ratio of three parts of liquid reflux to one of overhead products is chosen for the operation of the tower, the balance around the top tray will be: (on basis 1 mol. of overhead product)

Streams leaving tray		= Streams entering tray		
Vapor from tray	+ Liquid overflow downward	Vapor rising into tray	+	Liquid reflux fr. condenser
C_3 4 mols (.738)	+ 3 mols (.449)	= 4 (y_3)	+	3 (.738)
C_4 4 mols (.257)	+ 3 mols (.519)	= 4 (y_4)	+	3 (.257)
C_5 4 mols (.005)	+ 3 mols (.032)	= 4 (y_5)	+	3 (.005)

By solving any two of the three above equations, the composition of the vapor from Tray No. 2 can be determined.

$$C_3 \quad y_3 = \frac{.738 + (.449)\,3}{4} = .520$$

$$C_4 \quad y_4 = \frac{.257 + (.519)\,3}{4} = .455$$

$$C_5 \quad y_5 = \frac{.005 + (.032)\,3}{4} = .025$$

1.000

} Vapor rising from tray number 2.

Liquid on tray No. 2

The temperature on tray No. 2 is first assumed to be 140° F.

1st Trial

	π		y	=	p	x
C_3	152.68	×	.520	=	307	.259
C_4	152.68	×	.455	=	95	.733
C_5	152.68	×	.025	=	32	.120
						1.112

Assume Temperature = 150° F.

2nd Trial

	π		y	=	p	x
C_3	152.68	×	.520	=	340	.234
C_4	152.68	×	.455	=	110	.630
C_5	152.68	×	.025	=	37	.103
						.967

Assume Temperature = 148° F.

3rd Trial

	π		y	=	p	x
C_3	152.68	×	.520	=	330	.240
C_4	152.68	×	.455	=	106	.651
C_5	152.68	×	.025	=	35	.109
						1.004

Material Balance around plate No. 2

C_3 4(.520) + 3(.240) = $4y_3$ + 3(.449)
C_4 4(.455) + 3(.651) = $4y_4$ + 3(.519)
C_5 4(.025) + 3(.109) = $4y_5$ + 3(.032)

y_3 = .363
y_4 = .555
y_5 = .082
1.000

Liquid on Tray No. 3

Assume a temperature of 170° F.

π		y	=	p	x
152.68	×	.363	=	415	.1335
152.68	×	.555	=	145	.5840
152.68	×	.082	=	49	.2550
					.9725

Try temperature of 165° F.

152.68	×	.363	=	390	.1420
152.68	×	.555	=	130	.6520
152.68	×	.082	=	45	.2780
					1.0720

Temperature = 168° F.

Composition: C_3 = .1359, C_4 = .6028, C_5 = .2613, 1.0000 } Liquid on tray No. 3

Material balance around plate No. 3

C_3 4(.363) + 3(.1359) = $4y_3$ + 3(.240)
C_4 4(.555) + 3(.6028) = $4y_4$ + 3(.655)
C_5 4(.082) + 3(.2613) = $4y_5$ + 3(.109)

y_3 = .285, y_4 = .516, y_5 = .199, 1.000 } Vapor from tray No. 4

Liquid on Tray No. 4

Assume a temperature of 185° F.

					x
C_3	152.68	×	.285	=	480	.0902
C_4	152.68	×	.516	=	168	.4680
C_5	152.68	×	.199	=	62	.4900
						1.0482

Assume a temperature of 190° F.

					x
C_3	152.68	×	.285	=	505	.0850
C_4	152.68	×	.516	=	177	.4450
C_5	152.68	×	.199	=	65	.4700
						1.0000

These plate-to-plate calculations are shown graphically in Figure 1.

Application of "K" Charts

These equilibrium calculations can be made by use of the "K" charts which probably are more nearly accurate than the vapor-pressure chart, since the "K"

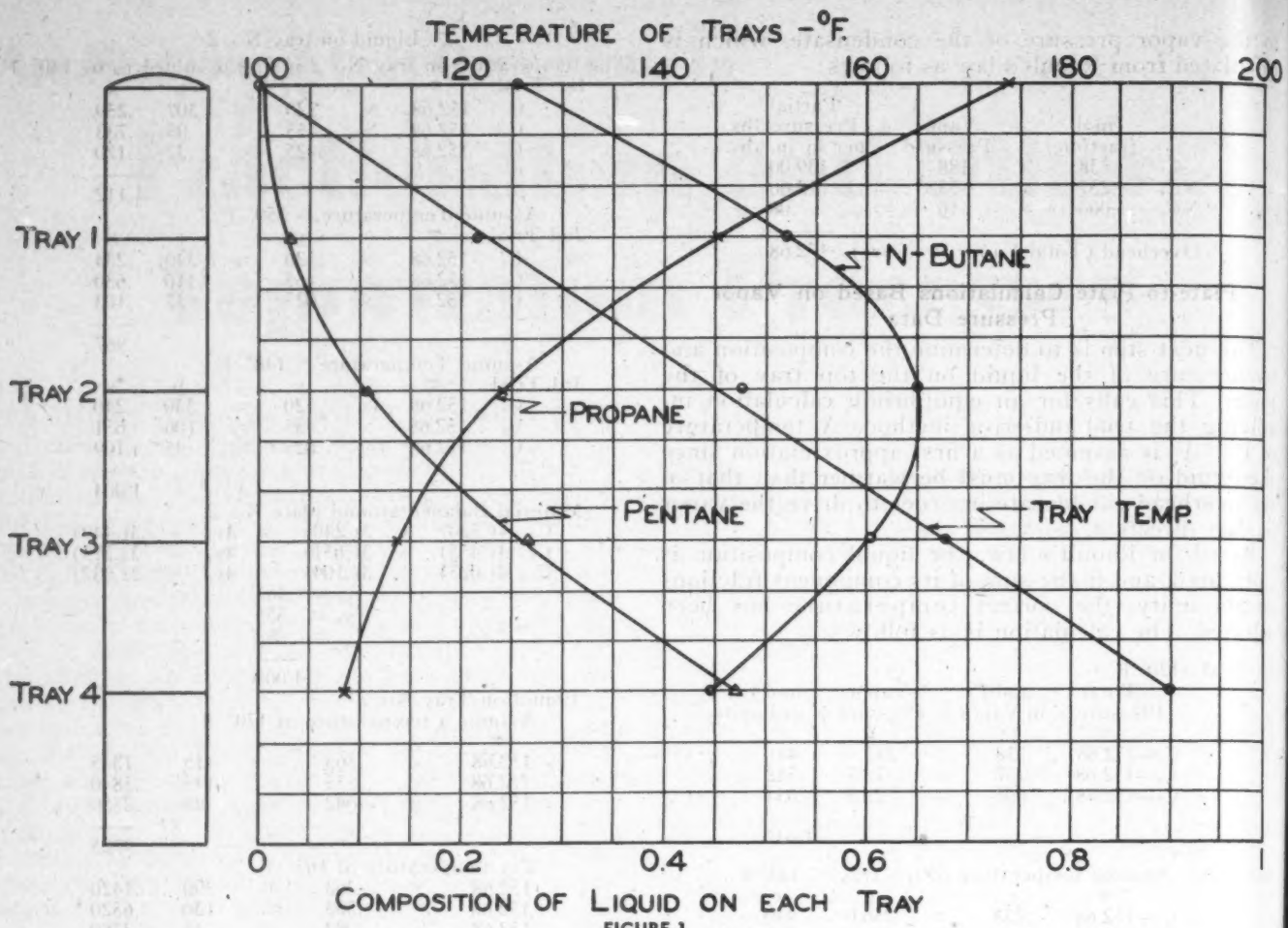


FIGURE 1

Variation in composition and temperature through four top trays of a fractionator

values are based on experimental data. In the above equilibrium calculation, a temperature of 190° F. is assumed:

Pressure = 152.68 pounds.

				$\frac{p}{\pi}$
Y	=	K	X	
.285	=	2.25	.1265	3.300
.516	=	.110	.4700	1.160
.199	=	.51	.3900	.427

According to the "K" charts the volatility of propane is less than the vapor pressure chart value and that of pentane greater than the vapor pressure reading.

Plate-to-Plate Calculations Based on "K" Values

Liquid on Top Tray No. 1. Assume a temperature of 125° F.

	y	=	K x	or	x
C_3	.738	=	1.42 x_3		.519
C_4	.257	=	.56 x_4		.458
C_5	.005	=	.22 x_5		.023
					1.000

A material balance around the top tray No. 1 is then made in order to get the composition of the vapor rising from tray No. 2.

		Liquid		Vapor to		Liquid to
Vapor from 1	+	from 1	=	1 tray	+	1 tray
C_3 4(.738)	+	3(.519)	=	$4y_3$	+	3(.738)
C_4 4(.257)	+	3(.458)	=	$4y_4$	+	3(.257)
C_5 4(.005)	+	3(.023)	=	$4y_5$	+	3(.005)

$y_3 = .5740$
$y_4 = .4075$
$y_5 = .0185$
1.0000 } Vapor from tray No. 2

Liquid on Tray No. 2. Assume Temperature = 150° F.

First Trial

y	=	Kx				
.5740	=	1.75	x_3	x_3	=	.328
.4075	=	.77	x_4	x_4	=	.530
.0185	=	.32	x_5	x_5	=	.058
						.916

Liquid on Tray No. 2. Assume Temperature = 140° F.

Second Trial

.5740	=	1.55	x_3	x_3	=	.370
.4075	=	0.70	x_4	x_4	=	.582
.0185	=	0.28	x_5	x_5	=	.066
						1.018

Therefore the temperature of plate 2 = 142° F. and the liquid:

$C_3 = .363$
$C_4 = .572$
$C_5 = .065$
1.000 } Liquid on tray No. 2

A material around tray 2.

From Tray				To Tray		
C_3 4(.5740)	+	3(.363)	=	$4y_3$	+	3(.519)
C_4 4(.4075)	+	3(.572)	=	$4y_4$	+	3(.458)
C_5 4(.0185)	+	3(.065)	=	$4y_5$	+	3(.023)

$y_3 = .4820$
$y_4 = .4930$
$y_5 = .0250$ } Vapor from Tray No. 3

Liquid on Tray No. 3. Assume 160° F. for first trial.

	y	=	Kx				
C_3	.482	=	1.90	x_3	x_3	=	.253
C_4	.493	=	.85	x_4	x_4	=	.581
C_5	.025	=	.36	x_5	x_5	=	.069
							903

Liquid on Tray 3, assume a temperature = 150° F.
Second trial.

	y		Kx				
C_3	.482	=	1.75	x_3	x_3	=	.275
C_4	.493	=	.77	x_4	x_4	=	.640
C_5	.025	=	.32	x_5	x_5	=	.078
							.993

Temperature = 149° F. Liquid $x_3 = .277$, $x_4 = .645$, $x_5 = .078$ } Liquid on tray 3.

Material balance around tray 3.

	From Tray				To Tray		
	Vapor		Reflux		Vapor		Reflux
C_3 =	4(.482)	+	3(.277)	=	$4y_3$	+	3(.363)
C =	4(.493)	+	3(.645)	=	$4y_4$	+	3(.572)
	4(.025)	+	3(.078)	=	$4y_5$	+	3(.065)

$y_3 = .418$, $y_4 = .548$, $y_5 = .044$ } Vapor from Tray No. 4

Liquid on tray 4. Assume Temperature = 160° F.

y		Kx				
.418	=	1.90	x_3	x_3	=	.220
.548	=	.85	x_4	x_4	=	.643
.044	=	.36	x_5	x_5	=	.122
						.985

Temperature = 158° F. on tray 4

Composition of Liquid

$x_3 = .221$, $x_4 = .647$, $x_5 = .122$ } Liquid on tray 4

Material balance around tray 4

From				To		
4(.418)	+	3(.221)	=	$4y_3$	+	3(.277)
4(.548)	+	3(.647)	=	$4y_4$	+	3(.645)
4(.044)	+	3(.122)	=	$4y_5$	+	3(.078)

$y_3 = .376$, $y_4 = .550$, $y_5 = .074$, 1.000 } Vapor from tray 5.

Liquid on tray 5. Assume a temperature = 170° F.

y	=	Kx				
.376	=	2.05	x_3	x_3	=	.183
.550	=	.93	x_4	x_4	=	.592
.074	=	.40	x_5	x_5	=	.184
						.959

Liquid on tray 5. Assume a temperature = 165° F.

.376	=	1.98	x_3	x_3	=	.190
.550	=	.89	x_4	x_4	=	.616
.074	=	.38	x	x	=	.194
						1.000

} Liquid on Tray No. 5

The temperature at the base of the tower can be determined by trial and error. Assume a temperature of 200° F.

y	=	Kx				
y_3	=	2.40	(.005)	y_3	=	.012
y_4	=	1.20	(.395)	y_4	=	.474
y_5	=	.57	(.600)	y_5	=	.326
						.812

Second trial—assume a temperature of 220° F. for the base.

y_3	=	2.60	(.005)	y_3	=	.013
y_4	=	1.40	(.395)	y_4	=	.555
y_5	=	.69	(.600)	y_5	=	.414
						.982

} Vapor from Bottom Product

Approximate temperature of base of tower = 222° F.

From these two sets of calculations, it is easily seen that conditions or limitations were fixed upon the tower in the way of reflux ratio, and overhead product which makes it possible to obtain a composition approximating that of the incoming feed.

The writer has submitted the problem to a class of 15 chemical engineering students, assigning a different set of conditions for each member of the class, with the result that several solutions were obtained that finally gave compositions comparable to the feed. The set of conditions which netted the closest approximation to feed composition called for an overhead product of 2.0 mol percent normal pentane and a bottoms of 39.5 percent normal butane and 58.5 percent normal pentane, with a reflux ratio of 4 parts of reflux to 1 of product.

From the foregoing calculations, it is readily seen that an exact solution of the theoretical tray requirements for as simple a mixture as three components is like "hunting for a needle in a hay stack," so numerous are the combinations of overhead and bottom products and reflux ratios only one which will fit into the "groove."

Many simplifying methods (see literature cited) have been offered as a basis for fractionator design. Experience has also been a big contributor in design progress since nothing is as sure as the trial-and-error method although it is often an expensive route to follow. Oftentimes, however, the elementary empirical method of attacking the problem is the only one to pursue. Indeed the petroleum refining industry has built itself up largely through this rough-and-tumble fashion. Narrowing margins of profit, however, call for the application of engineering principles by the surer method, the scientific approach.

LITERATURE CITED

[1] Albright, J. C. National Petroleum News, Vol. 24, No. 1, page 32 (Oct. 10, 1934).
[2] Badger and McCabe, Elements of Chemical Engineering, McGraw-Hill Book Co.
[3] Brown and Souders, Trans. Am. Inst. Chem. Engrs. 30, 438 (1934).
[4] Brown, Souders and Hesler, Ibid, 30, 467 (1934).
[5] Brown, Souders and Nyland, Ind. Eng. Chem. 24, 522 (1932).
[6] Brown, G. G. Trans. A. I. Ch. E. 32, p. 231 (1936).
[7] Brown and Souders, Science of Petroleum, Vol. 2, p. 1567-71, (Oxford University Press (1938).
[8] Cope and Lewis, Ind. Eng. Chem. 24, p. 498 (1932).
[9] Fenske, M. R. Ind. and Eng. Chem. 24, p. 482 (1932).
[10] Garton and Huntington, Refiner and Nat. Gaso. Mfr. Jan. and Feb. 1935.
[11] Gilliland, Ind. Engr. Chem. 27, 260 (1935).
[12] Gunness, Ind. Eng. Chem. 29, 1092 (1937).
[13] Katz and Brown, Ind. Eng. Chem. 25, p. 1373 (1933).
[14] Lewis and Cope, Ind. Eng. Chem. 24, 498 (1932).
[15] Lewis and Matheson, Ind. Eng. Chem. 24, p. 494 (1932).
[16] McCabe and Thiele, Ind. Eng. Chem. 17, p. 605 (1925).
[17] Ragatz, Nyland, Souders and Brown, Trans. A. I. Ch. E. 30, p. 477 (1934); Brown, Souders, Nyland and Hessler, Ind. and Eng. Chem. 27, p. 383 (April, 1935).
[18] Robinson and Gilliland. Elements of Fractional Distillation, McGraw-Hill (1939).
[19] Souders, Selheimer and Brown, Ind. Eng. Chem. 24, p. 517 (1932).
[20] Thiele and Geddes, Ind. Eng. Chem. 25, p. 289 (1933).
[21] Underwood, A. J. V., Trans. Inst. Chem. Engrs. (London) 10, p. 119 (1932).

Textile Wetting And Foaming Agents From Petroleum

E. PROFFT

"Fette und Seifen," 49, No. 12, P. 868 (1942)
Translated by Edwin J. Barth, Petroleum Technologist

ONE of the most rapidly developing chemical fields in recent years is that of entirely new and novel synthetics for use in the textile industry. These synthetics all possess the property of so-called "surface activity." These materials are classified, according to their use, as wetting-out, foaming, washing, dispersing, or emulsifying agents. New washing and cleansing agents are developments of improved soaps, especially that of Turkey-red oil. Carriers for surface activity are usually aliphatic derivatives. Nearly all surface active agents are soluble clear (or colloidal) in water, and materially lower the surface tension.

In general one distinguishes the following groups of surface-active agents:

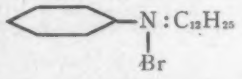
1. Anion active
2. Cation active
3. Anion + cation active

This grouping depends on whether the group responsible for the surface-activity (for instance, an alkyl chain derivative) resides in the anionic, cationic or both parts of the complex molecule. The greatest proportion of the well known textile aids are anion-active; such are sodium oleate, sodium cetyl sulphate, sodium sulpho-vicinoleate, etc.

The present report will deal, however, with cationic active substances and with, for example, the salts of the higher aliphatic bases.

In contrast to the anionic materials it can be said that the cation-active substances do not contain such water-soluble groups as COOH or SO_3H, etc. They are of different constitution, as will be shown herein.

a. Quaternary Ammonium Compounds[1] (also phosphonium and sulphonium derivatives): such as, triethylcetylammonium iodide, $(C_{16}H_{33})\ (C_2H_5)_3NI$.
b. Basic urethanes (derivatives of ethylenediammine) and their salts[2,3]. For instance, the diurethane of menthol, $(C_{10}H_{19} \cdot O \cdot CO)_2 \cdot NCH_2 \cdot CH_2 \cdot N(C_2H_5)_2$, the chlorhydrate is called "Emulsamin."
c. Acid amides of diamines and fatty acids[3-7], as an example, diethylaminoethyloleylamide, known on the continent as "sapamin."
d. Alkylated derivatives of (C).[3-7]
e. Alkylpyridinium derivatives (8-12); as an example, laurylpyridiniumbromide:



f. Salts of higher aliphatic bases (13; an example, cetylaminechloryhydrate: $C_{16}H_{33} : NH_2 : HCl$.

An inspection of the above six types of cationic agents shows that groups a-d, compared to (c) and (f) show the disadvantage of being difficult to manufacture and are therefore expensive. Hartman & Kagi[3], the inventors of "Emulsamin," declare that the higher hydro-aromatic alcohols needed for the syntheses of (b) synthetics are entirely too expensive. Group (e) calls for pyridine, a not too available material when desired in pure form. Group (f) calls for the higher aliphatic alcohols, usually of animal or vegetable source, and are scarce even in normal times. Group (f) has the great advantage, however, of simple methods of synthesis and a not too complex structure, making the manufacture of these salts an attractive undertaking.

There exists, however, the alternative possibility of using, as raw starting material, the many types of petroleum and its manifold fractions.

Krafft discovered years ago, when working on determining the molecular weights of hexadecylaminhydrochloride (cetylaminhydrochloride), that this material behaved abnormally as well as showing unique colloid properties. Hartman and Kagi checked these findings in their own work and showed that the chlorhydrate of cetylamin was difficultly soluble in water. Of course this property is undesirable in textile agents. It would have aided the problem there to employ bases and their salts derived from petroleum to furnish the looked for water-soluble products. The use of petroleum fractions does not consist of synthesizing a known molecular weight chemical substance but to use narrow fractions of approximately known chain length material and more or less complicated mixtures of hydrocarbons which will eventually yield more satisfactory material of suitable solubility.

In starting out with petroleum fractions as raw stock for the reactions the procedure is to chlorinate the particular fraction, and reacting the resulting chloro-derivative with ammonia. As will be shown, the procedure will produce valuable "textile-aid" synthetics of outstanding properties. Enlarging and modifying the procedure the author has been able to produce very excellent wetting-out and foam agents.

As to methods of procedure, it had been presupposed from the beginning that the paraffins were really about as inert as any series could be and that little could be done with this series of hydrocarbons. Later one became convinced that[12] under specified conditions the paraffins could be made very reactive and one of the first reactions studied was that of chlorination. Chloro-derivatives represent very reactive substances and are ideal starting-materials for a host of reactions.

Pelouze and Cahors had chlorinated several normal paraffins. Their procedure was not described, except in the case of hexadecane, where one reads, "at 40°-50° C." Previously Schultz[15] undertook the chlorination of decane. The chlorination took place with appreciable evolution of heat so that Schultz advocated at that time to slow down the reaction by using chlorine previously diluted with carbon dioxide. In order to minimize the formation of large amounts of higher chloro-derivatives this investigator recommended using only half the amount of chlorine calculated to give him the monochloro-derivative.

There are many patents today dealing with the chlorination of petroleum fractions. Zelinsky[16] presented a procedure in 1902 for preparing fatty acids from chlorides derived from the chlorination of petroleum fractions. The exact procedure used is described in his patents. More recently the chlorination petroleum fractions has been described in the patent literature of the I. G. Company[17-20] and of the Sharples Solvents Company in Philadelphia[21]. Suitable petroleum materials for chlorination are the soft and hard paraffin waxes, vaseline-oils, transformer-oils, and the Sharples patent mentions the use of pentane. The chlorination in all cases is carried out by slightly warming the stocks, say 50°-100° C; in the case of pentane even up to 200° C. Polychloro-derivatives containing 2-8 mols of chlorine are obtained; in the case of pentane, the monochlor-pentane is produced.

For the purpose of producing amines and their salts from the chloro-derivatives, the latter, of course, are reacted with ammonia. The syntheses of organic bases, according to this fundamental procedure, is well known to organic chemists. Pelouze and Cahors studied this reaction in 1863 while making chloro-derivatives from petroleum. Chlorinated paraffins were heated with alcoholic ammonia, obtaining mixtures of primary, secondary, and tertiary amines of the paraffin series.

Von Braun[22] reported, in 1937, his success in converting n-amyl, n-octyl, and n-dodecylbromide into amines using aqueous ammonia. The patent literature is quite complete on this procedure since many of the patents on the chlorination of the paraffins also include and conclude with the synthesis of many types of amines. The use of ammonia in aqueous or alcoholic solution is preferred but according to the literature substances other than ammonia, which yield ammonia itself, are also mentioned, such as ammonium carbonate, ureau, etc. The hydrochlorides of the amines are produced in the reaction.

These substances appear to be excellent textile-aids. Their solutions in water are colloidal, similar to regular soaps; their

foam properties are considerably better than those of soap solutions. They emulsify fats and show marked dispersing and wetting-out properties. The amine salts furthermore show excellent detergent and cleansing properties, not usually shown by ordinary soaps. Their solutions are stable towards acids, metallic salts—also the heavy metal salts. These properties make possible the uses of these amine compounds in the preparation of wool, as wetting-out agents, and also as additions to hard water in the washing of alkali sensitive textiles, such as wool. They have the disadvantage of being unstable as solutions in the presence of alkalies which decompose the salts, foaming free amines. They are unsuited as textile-aids for use in alkaline medium. Sodium bicarbonate "salts-out" some of the derivatives from their solution.

I have tested the surface-activity of such cationic wetting-agents and compared them to preparations made from a petroleum fraction under special conditions and control. In this work I used exclusively monochloro products which were carefully made by cooling the reaction, etc., rather than using the higher chlorinated oil fractions. I arrived at an important conclusion: the surface-active agents thus made by reaction with ammonia using exclusively the monochloro oils for this reaction, show an extraordinarily high wetting-out and good foam tendency, and are far superior to those made using polychlorinated fractions. This is contrary to the accepted trade opinion up to now since even the products from polychloro derivatives are considered valuable textile-aids. The amine salt compounds are also superior to the alkyl-pyridinium derivatives which are simply made in reactions of pyridine and the monochloro petroleum fractions.

Below we report the work which was undertaken in the laboratory. Four different products were made:

(1) Reaction product with ammonia using terachloro-paraffin wax.
(2) Same but using dichloro-paraffin wax.
(3) Reaction products using a fraction of petroleum chlorinated to contain mostly the monochloro material.
(4) Reaction product of pyridine and substantially monochloro-petroleum fraction.

Products under (1) and (2) were made as follows:

Chlorine gas is led into molten paraffin wax (100gm.) of 295 av. mol. weight, (approximately $(C_{21}H_{44})_1$ at 70° C., in sunlight until there is an increase in the one case of 48 gm. (corresponding to 4 mols. of chlorine), and in the second case of 24 gm. (2 mols. of chlorine). The tertachloro and dichloro derivatives were then treated with:

For case (1), a solution of 74 gm. NH_3, in 750 gm. alcohol, and

For case (2), a solution of 44.5 gm. ammonia in 385 gm. alcohol.

The treatments are carried out in a pressure autoclave at 140°-170° C. After cooling the apparatus the brown alcoholic solutions in each case were freed of the crystalized ammonium chloride and the alcohol evaporated. The hydrochlorides of the bases from the tetra- and the dichloro-paraffin waxes are thus obtained as viscous oils.

TABLE 2
Foam Experiments

No.	Type of Amine Salt	Percent Concentration	Time in Minutes	Foam Height
1.	From tetrachloro hard paraffin wax and ammonia	1.0 0.5	Foam fell to a height of 2 mm. in 1 min. No foam remained after 5 min. in either case.	
2.	From dichloro hard paraffin wax and ammonia	1.0	5	46
		1.0	15	35
		1.0	30	25
		1.0	60	8
		0.5	5	43
		0.5	15	29
		0.5	30	20
		0.5	60	6
3.	From monochloro-kerosine and ammonia	1.0	5	93
		1.0	15	58
		1.0	30	50
		1.0	60	49
		0.5	5	87
		0.5	15	85
		0.5	30	83
		0.5	60	82
4.	From monochloro-Kerosine and pyridine	1.0	5	73
		1.0	15	56
		1.0	30	49
		1.0	60	28
		0.5	5	67
		0.5	15	54
		0.5	30	45
		0.5	60	23

TABLE 1
Wetting Experiments

No.	Type of Amine Salt	Percent Concentration	Wetting Time (Sec.
1.	From tetrachloro-paraffin wax and ammonia.....	1.00	11
		0.50	104
		0.25	323
2.	From dichloro-paraffin wax and ammonia.....	0.5	21
		1.0	63
		0.25	230
3.	From monichlorinated kerosine and ammonia.....	1.0	3
		0.25	62
4.	From monochlorinated kerosine and ammonia.....	1.0	124
		0.5	290
		0.25	505

The product to be made under item (3) above was prepared as follows: chlorine gas is led into 78gm. of kerosene, placed in sunlight, and provided with adequate cooling until there is a weight increase of 20 gm. (about 1 mol. of Cl.). The yellow chlorinated oil is next washed with water, dilute caustic soda solution, and finally with water, followed by drying with calcium chloride (anhydrous). Eighty gm. of this product were placed in a stirring-autoclave with 120 cc. of a solution of ammonia in denatured alcohol (140 gm. of NH_3 per liter) and the mixture heated four hours at 170° C. The reaction product is then removed, heated on an open water bath to remove excess of ammonia and alcohol.

The oil so obtained is washed and extracted several times with water. The aqueous extracts are then concentrated by evaporation on a steam-bath. The material thus obtained are the hydrochlorides of the bases derived from petroleum.

To obtain the product as mentioned under item (4) above, practically the same procedure as for oil in item (3) is carried out: 90 gm. of the chlorinated kerosine were heated for four hours at 160°-170° C. with 35 gm. pyridin. After cooling the reaction-product it is extracted and washed with water, the aqueous extract is separated from any oily cracked products, and concentrated by evaporation on the steam bath. The brown viscous oil so obtained consists of the hydrochlorides of the quaternary bases from pyridin and the kerosine-chloride.

Wetting-out times for the four compounds thus obtained are shown in Table 1.

It can be seen that the wetting-times are outstanding for the compound made from chloro-kerosine and ammonia, and is quite superior to the materials made from hard paraffin wax. The wetting-time was poorest for the quaternary product in (4) which was made from the same kerosine chloride as was used for product No. 3.

The foaming tests were carried out by shaking 10 cc. of the compound in solution for 30 seconds, measuring the foam produced with an accurate rule.

In Table 2 are shown the foaming tendencies of the compounds that were produced.

The compound in No. 1 (from tetrachloro-wax) was worthless due to its poor foaming ability. The quaternary product behaved in its foaming tendencies much better than the product from the dichloro-wax reaction.

The results show the value of products that can be made from petroleum and its fractions instead of using the valuable and edible animal and vegetable oils for this purpose. The future trend in this direction for making textile-aids from petroleums appears extremely promising, and new derivatives from these for the textile and laundry industry promise to be outstanding.

LITERATURE CITED

[1] A. Reychler; Bull. Soc. Chim. Belgique 27, 217, 1913; C. 1913; II, 1376, 7.
[2] Hartman u. Kagi; Schweiz. med. Wschr. 54, Nr. 7 (1924).
[3] Dieselben, Saure Seifen, Z. angew. Chem. 41, 127 (1928).
[4] Schweiz. Pat. 107202.
[5] Schweiz. Pat. 107776, 107782.
[6] Schweiz. Pat. 108846.
[7] Am. Pat. 1527869.
[8] Meyer u. Jakobson; Lehrbuch der org. Chemie II, 3, 798 (1920).
[9] H. Bertsch, "Uber die Wirkung kationaktiver Fettstoffe auf die pflanzliche Faser." Z. angew. Chem. 48, 52 (1935).
[10] Brit. Pat. 379 396.
[11] Brit. Pat. 414 299.
[12] Franz. Pat. 743 973.
[13] Krafft. Ber. dtsch. chem. Ges. 29, 4330 (1896).
[14] Pelouze u. Cahors. Jahresber. Chem. 1863, 528.
[15] Schultz. Ber. dtsch. chem. Ges. 42, 3610 (1909).
[16] DRP 151 180.
[17] DRP 521 622.
[18] Am. Pat. 1 948 924.
[19] Brit. Pat. 339 962.
[20] Am. Pat. 2 063 934.
[21] Am. Pat. 2 006 058.
[22] v. Braun, Ber. dtsch. chem. Ges. 70, 929 (1937).

Detergency or Dispersancy in Heavy Duty Engine Oils

CARL W. GEORGI
Technical Director, Research Laboratories,
Quaker State Oil Refining Corporation

ADDITIVE-TREATED oils for heavy-duty-engine service, of the type meeting the requirements of United States Army Specification 2-104B, have come to be known as "detergent oils." Oils of this type containing oxidation and bearing-corrosion inhibitors and "detergent" additives are now widely recognized as being much superior to straight-mineral oils for lubrication of engines in severe or difficult service.

The origin or originator of the term "detergent oil" is obscure, but since this designation has become so popular, it was considered of interest to investigate the fitness of this name for heavy-duty type oils.

Webster's definitions are:

Detergent—cleansing, purging (adjective); a cleansing agent or solvent (noun).

Detergency—cleansing quality or power (noun).

A literal interpretation of "detergent oil" thus indicates an oil having cleansing, purging or solvent properties which would imply its ability to remove sludges and deposits from dirty engines.

Dispersing action has frequently been mentioned in connection with heavy duty oils and Webster defines this:

Disperse—To place in a state of suspension, as finely divided particles in some other substance (verb).

Dispersion—Act of dispersing or state of being dispersed (noun).

To complete the petroleum dictionary, it seems desirable to coin and define two additional words which do not appear in Webster.

Dispersant—An agent for imparting dispersing powers or properties. A dispersing agent or medium (noun).

Dispersancy—Dispersing quality or power (noun).

THIS study shows "dispersant" oils more apt than "detergent" oils as descriptive of the lubricants fortified with additives for use in internal-combustion engines. While no great harm can come from the inaccuracy of terms, emphasis should be placed upon the fact that the purpose of the heavy-duty oil is to keep the engine clean for maximum periods of operation. It follows that the oil should be used for limiting fouling, rather than for cleaning the engine, as use for the latter purpose in a dirty engine may result disastrously.

This paper was presented before the National Fuels and Lubricants Meeting of the Society of Automotive Engineers, at Tulsa, November 9-10, 1944.

Detergency thus tends to imply the property of cleaning out dirty engines, whereas dispersancy would indicate the property of maintaining insoluble matter (sludges and contaminants) in dispersion in the oil so that they will not settle out and ultimately build up as deposits.

The question might therefore be:

Is the function of heavy duty, additive-treated oils to clean up and rejuvenate dirty engines or to maintain clean engines in clean condition for the maximum possible periods of operation? In order to evaluate more definitely these respective functions a series of laboratory and road tests were conducted over the past few years.

Figure 1 shows two pistons from 480-hour test runs on a

FIGURE 1

FIGURE 2

FIGURE 3

FIGURE 4

single-cylinder diesel engine. These tests were made in accord with Coordinating Research Council Test Designation L-1-1143.[3] The piston on the left is from a 480-hour test with a conventionally refined SAE 30 straight-mineral oil. The piston skirts and ring zone show heavy varnish and carbon deposits and most of the piston rings are stuck. This piston is obviously in very poor condition as a result of oxidation and deterioration of the oil on the hot piston surfaces and the subsequent build-up of these oil-oxidation products as deposits. The piston on the right is from a 480-hour test with a solvent-extracted, high-viscosity-index oil, SAE 30, containing inhibitor and "detergent" additives. The striking difference between these two pistons requires little comment, beyond mentioning that the inhibitor additive minimized oil oxidation and any insoluble oxidation products which did develop were largely kept in dispersion in the oil, instead of adhering to the piston surfaces and building up as deposits. Figure 1 serves to illustrate the typical difference between straight-mineral and heavy-duty oils for lubricating engines in heavy-load service wherein high ring-belt temperatures develop.

Figure 2 shows a typical piston from a 6-cylinder diesel-engine test, run for 80 hours with an SAE 30 straight-mineral oil. Under the particular test conditions the oil was not oxidized to any marked extent, either in the crankcase or on the piston surfaces, and the principal factor involved was heavy contamination of the oil with soot and carbon from the combustion chambers. This test procedure was set up to simulate conditions so frequently encountered in service, wherein imperfect combustion causes formation of large quantities of soot, considerable of which work past the pistons to contaminate the crankcase oil.

The piston in Figure 2 from the run with straight-mineral oil contains heavy deposits of a pasty, rather gummy consistency, which cover almost the entire piston surfaces and which have completely plugged the upper oil-control ring and partially filled the lower oil ring.

Figure 3 shows a typical piston from an identical 80-hour diesel engine test with an SAE 30 heavy-duty oil. The marked improvement in piston and oil-ring cleanliness resulted from the "detergent" additive contained in the oil, which acted to maintain the soot and carbon contamination in dispersion in the oil so that it did not adhere and deposit on the engine working surfaces. In this test the oil became extremely black and dirty, but there is little argument that it is much better to keep insoluble contaminants in dispersion in the oil rather than to let them deposit out and adhere to engine surfaces.

Figure 4 shows two pistons from light truck engines operated in short-haul, city-delivery service over a period of four winter months. The left-hand piston is typical of that removed from an engine which was lubricated with 20W straight-mineral oil and the piston on the right is from an engine serviced with 20W heavy-duty oil.

The operating conditions of this truck fleet were such that high rates of combustion-chamber blow-by prevailed, causing rapid and heavy contamination of the crankcase oils with fuel dilution, moisture, soot and lead residues from the lead-tetraethyl-treated gasoline.

The piston from the engine lubricated with straight-mineral oil shows the typical condition of oil-ring plugging encountered. These deposits were of a soft pasty consistency and were composed largely of lead compounds and soot.

The right-hand piston in Figure 4 illustrates the effectiveness of heavy-duty oil in minimizing the development of this type of contamination sludge in engines used in light-duty, low-temperature service.

It should be mentioned, however, that at the time this truck fleet was converted from straight-mineral oil to heavy-duty additive oil, a comprehensive program of improved engine maintenance and operation was adopted. This consisted essentially of installation of radiator covers and crankcase-pan insulation to provide higher coolant and crankcase-oil temperatures and faster engine warm up, so that cold-engine operation favoring excessively high rates of crankcase contamination was greatly minimized. A preventive-maintenance program was also adopted covering periodic fuel- and ignition-system inspection, again to minimize the chances of engine-operating conditions favoring high rates of crankcase contamination.

It is not known therefore, just how much of the improvement in engine cleanliness was brought about by the change to heavy-duty oil, and how much resulted from the improved maintenance and inspection program. The fleet operator was interested only in getting out of his sludge and ring-plugging troubles, so that there was no opportunity to run any extensive comparison tests to establish the relative improvements gained by the change to heavy-duty oil compared to those gained by more careful engine maintenance and operation.

There is little question but that the change to heavy-duty oil contributed to improved engine cleanliness in this fleet, but there is likewise no argument that the program of better engine maintenance was also a most pertinent factor. In any event, the combination of heavy-duty oil plus more careful engine maintenance got this truck fleet out of serious contamination and sludge deposit difficulties.

Figures 1 through 4 serve to illustrate what can be accomplished by the so-called "detergent" constituent of heavy-duty oils. These photos also illustrate that heavy-duty oils perform two separate functions, namely to minimize engine deposits and dirtiness derived from oil oxidation, and those derived from contamination of the crankcase oil with combustion-chamber blow-up products—chiefly soot and carbon in diesel engines, and lead compounds in gasoline engines.

Figures 1 through 4 also involve the question of "detergency or dispersancy in heavy-duty oils?" All of these tests were started with clean engines and their condition at the conclusion of the respective tests indicated the ability of the various oils to either permit or prevent sludge and deposit accumulations. No question of cleaning up dirty engines was involved so that in all of these examples the property of "dispersancy" was evaluated rather than that of "detergency."

Laboratory-Engine Detergency Tests

In order to study more directly the actual detergent action of heavy-duty oils, a series of tests was run starting with dirty engines. In the preliminary laboratory-engine tests, a procedure was developed to prepare dirty engines having

quite uniform deposits so that direct comparisons of the detergent action of various types of oils could be made.

Single-cylinder Lauson engines were used and the tests were made following closely in most respects the Oil Stability Procedure as outlined in the report of the Bench Test Group of the Coordinating Lubricants Research Committee.[2]

In preparing the "dirty" engines, 48-hour runs were made with an oil-sump temperature of 280° F. and a jacket-coolant temperature of 180° F., using a low viscosity index SAE-10 oil. Under these conditions the piston skirts developed a heavy coating of varnish and the oil-ring grooves were partially filled with soft, sticky deposits of oil-oxidation sludges. It should be noted that the piston deposits were composed entirely of a soft, sticky or pasty type, readily soluble in acetone, and were not of the hard, baked, insoluble resinous variety as encountered in engine operations involving very high piston temperatures. The soft, acetone-soluble type of piston deposit was particularly chosen in order to provide optimum conditions for evaluation of detergency or solvent characteristics of the heavy-duty oils. The "reference" piston in Figures 5, 6, and 7 shows typical piston condition after the 48-hour "dirtying" runs.

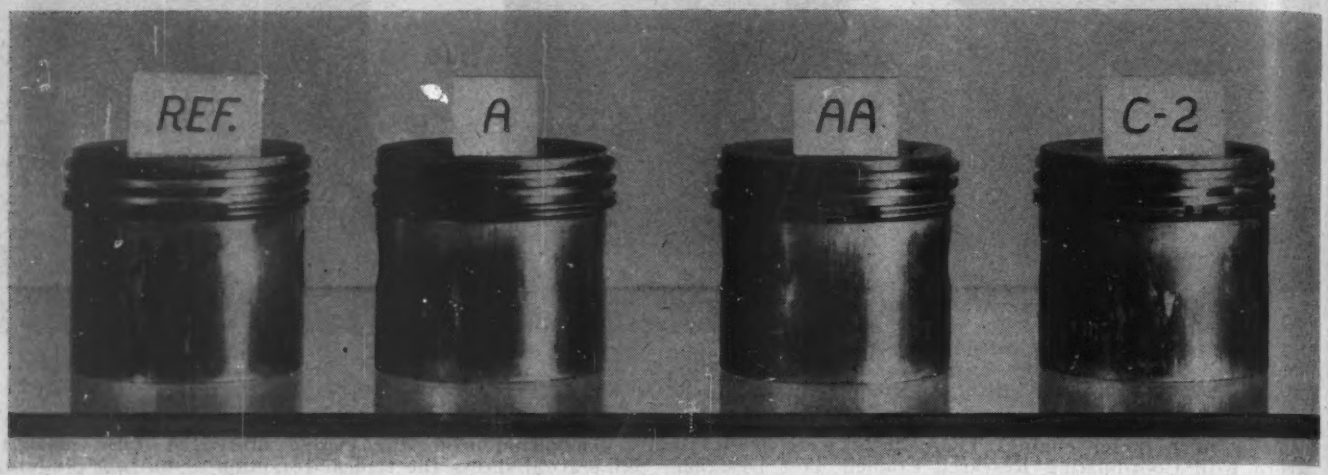


FIGURE 5

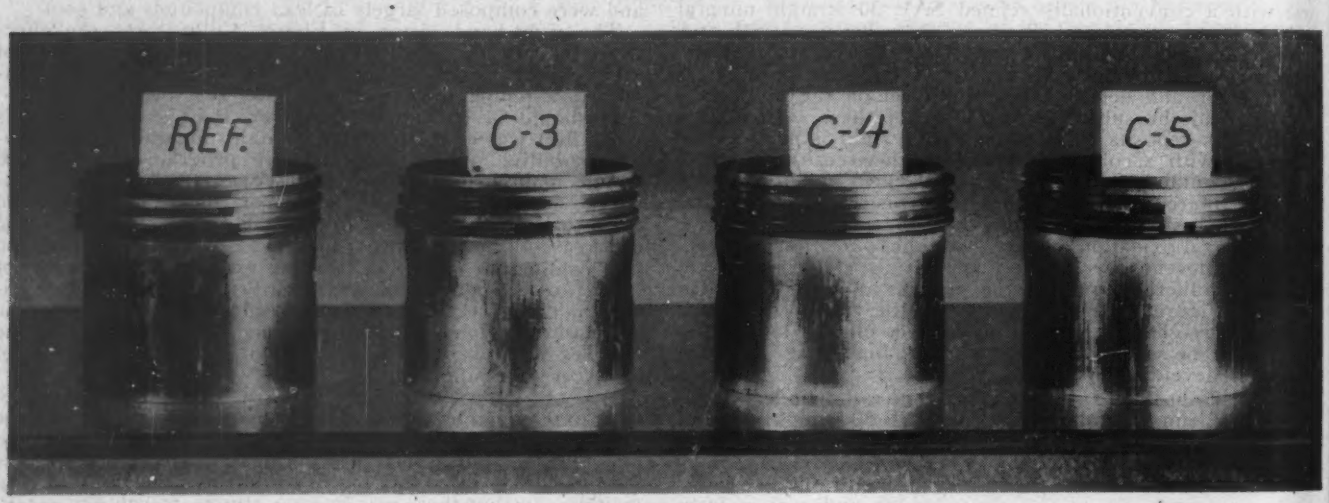


FIGURE 6

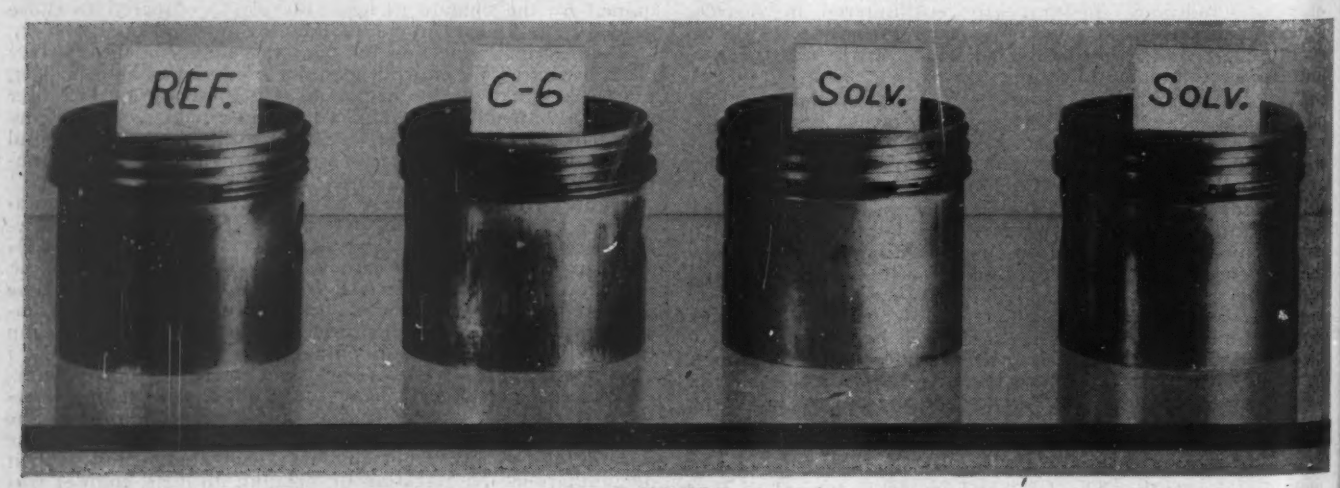


FIGURE 7

Following each 48-hour "dirtying" run, the piston was removed to check its condition and uniformity of deposits against a reference dirty piston. The engine was then reassembled, the low-viscosity-index oil drained and replaced

with the oil to be tested. Forty-eight-hour runs with 280° F. sump and 180° F. jacket were then made on each test oil, with a drain and refill at 24 hours.

Figure 5 shows results with three oils. Piston A is from a run with an SAE 30, conventionally refined straight-mineral oil. Comparison with the reference piston shows very little change, equivalent to essentially no detergent action. Pistons AA and C-2 are from runs with two commercial SAE 30 heavy-duty oils of the Army 2-104B type. Piston AA shows partial cleaning and removal of the oil-ring deposits but no appreciable action on the piston-skirt varnish. Piston C-2 shows substantially no change when compared with the reference piston.

Figure 6 shows three more pistons, C-3, C-4, C-5, from runs on three commercial heavy-duty oils all of the 2-104B type. Piston C-3 shows partial removal of the oil-ring deposits and some removal of the piston-skirt varnish on the thrust surfaces. Pistons C-4 and C-5 display almost no reduction in oil-ring deposits and slight removal of skirt varnish on the thrust surfaces. Piston C-6 in Figure 7 is from another commercial heavy-duty oil and indicates no material cleaning or removal of deposits, either from the oil ring or the piston skirts.

For purposes of comparison, the third piston, "Solv.", in Figure 7 is from a run with an SAE 30 oil containing an additive having true solvent action on varnishes, gums, and oxidation resins. Due to the fact this solvent additive is unstable on extended use at elevated temperatures, this test was run for four hours only. As shown, this piston was cleaned substantially free of all skirts and ring deposits.

The last piston in Figure 7 is from a one-hour run with a mixture of 60 percent diesel fuel, 20 percent motor oil, 10 percent butyl alcohol and 10 percent toluene in the crankcase. Mixtures of this type are quite frequently used in attempts to clean out badly sludged engines. Due to the volatile nature of the mixture, this test was run with 200° sump temperature and only for one hour. After this short run the piston skirts were much cleaner, with only scattered varnish stains remaining, and the oil ring and grooves were practically freed of deposits. The two solvent mixtures exerted considerably greater cleaning and deposit-removing action than did any of the heavy-duty oils, particularly when the difference in engine operating time is considered.

The conclusion to be drawn from these laboratory-engine tests is that heavy-duty oils possess but limited detergency when this term is taken to mean cleansing, purging or solvent power. As far as piston deposits derived from oil oxidation are concerned it appears that the essential function of heavy-duty oils is to prevent such oxidation products from adhering to metal surfaces (dispersancy) rather than to remove such deposits after they have formed (detergency).

Road Tests

The second phase of the study of detergency versus dispersancy consisted of a series of road tests. A variety of truck engines in different types of service and which had become quite badly fouled with sludge and deposits from operation with straight-mineral oils, were run from 1000 to 10,000 miles with heavy-duty oils. In each case, the engine was opened up at the start of the test for observation of deposit condition. Deposits were not removed or disturbed. In each test at least three drains and refills with heavy-duty oils were made and at the conclusion of each test the engine was again opened up for observation.

Figurt 8 shows two pistons from light truck engines operated in city delivery service wherein considerable difficulty with cold-engine contamination sludges was encountered. The left-hand piston is typical of that found in several of the engines in this fleet after some months of operation with straight-mineral oil. As indicated, oil-ring fouling was prevalent and the piston skirts were coated with quite heavy deposits. The oil-ring deposits were of a soft, pasty nature and consisted chiefly of lead compounds and soot. The piston-skirt deposits also contained considerable lead residues bonded to the skirts by sticky oil-oxidation resins. Although these skirt deposits were fairly heavy, in no instance were they found to have developed to the point of causing piston sticking in the cylinder bores.

The right-hand piston in Figure 8 is typical of those from engines in this fleet after operation for 1000 to 2000 miles with heavy duty oils. There was a noticeable improvement in oil-ring condition and appreciable reduction of piston-skirt deposits. The heavy-duty oils used thus displayed fairly effective detergent action in removing soft, pasty deposits from the pistons.

The general experience in this test series was that such engine parts as oil rings, pistons skirts, cranckcases and lower engine surfaces were appreciably cleaned and freed of soft, pasty, contamination sludges by the heavy-duty oils. On the other hand, engine sections such as valve chambers and push-rod and rocker-arm compartments, where oil flow was limited and where the deposits tended to be of a harder more adherent type, were not appreciably cleaned or benefited by the heavy-duty oils.

Peculiarly enough, in all cases where oil-pump screens were found to be heavily coated with deposits, the heavy-duty oils displayed little or no cleaning action, in spite of the vigorous oil flow at this point in an engine. In most instances oil-screen deposits were packed to a hard, adherent and granular coating which was not susceptible to removal. In several instances the oil screens were found to be dirtier and more heavily plugged after the runs with heavy-duty oil than before. In such cases, sludges loosened from other parts of the engine were apparently carried to the oil screen, thereby increasing the deposits.

Figure 9 shows two typical pistons from a heavy-load, long-haul fleet operation. With straight-mineral oils, considerable difficulty with ring sticking and oil-ring plugging was encountered, although the balance of the engine interiors remained reasonably clean and free of excessive deposits between overhaul periods. Typical engine service in this fleet apparently accentuated oil deterioration from high piston temperatures, while oxidation of the bulk oil in the crankcase or excessive oil contamination from low engine temperatures were not an appreciable factor.

The left-hand piston in Figure 9 is typical of those found in engines in this fleet after 20,000 to 40,000 miles operation

FIGURE 8

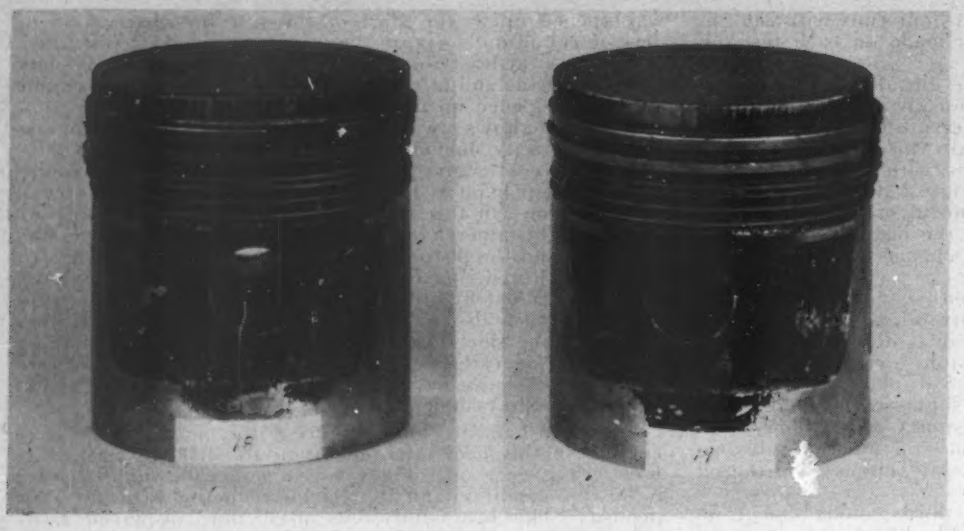


FIGURE 9

with uncompounded oil. Compression rings showed partial to complete sticking, the oil rings were badly fouled with hard carbon deposits, and the inner and outer piston surfaces were coated with baked varnish films. These piston deposits apparently originated as oil-oxidation sludges which built up on the pistons and then baked to hard, adherent varnish films and coke-like or carbonaceous deposits in the ring grooves and oil-ring slots.

The piston on the right in Figure 9 is typical of that from engines after 5000 to 10,000 miles of operation with heavy-duty oils. As shown, no appreciable removal of deposits resulted from the use of the additive-treated oils. This experience confirms that reported previously, that heavy-duty oils possess little cleansing or loosening action on deposits of a hard, adherent or baked character.

In summarizing the results of these tests, as well as numerous similar tests in other operations, the following conclusions seemed justified:

1. Heavy-duty oils can exert appreciable detergent or cleansing action on engine deposits of a soft, pasty and readily loosenable nature, particularly on those parts of an engine where copious oil flow or vigorous oil circulation occurs.

2. Heavy-duty oils display no appreciable detergent or cleaning properties on engine deposits of a hard, adherent or baked type or on those parts of an engine where oil flow and circulation is limited.

Another interesting and significant condition related to oil detergency was observed during the course of the road tests. In two instances addition of heavy-duty oil to badly fouled engines resulted in disruption of oil circulation and loss of oil pressure such that the engines had to be shut down to avoid possible damage from lack of lubrication.

In the one instance, a diesel engine in fluctuating-load operation had become badly fouled with mayonnaise-like deposits composed largely of soot and carbon particles. Within a few hours after addition of the heavy-duty oil, the oil pressure began to fluctuate from the normal 40 to 50 pounds to almost 0, so the engine was shut down. Upon inspection, it was found that considerable of the soft sludges had been loosened from the crankcase and lower engine surfaces. The large amount of solids which then became dispersed in the oil caused it to become exrtemely thick and viscous. Also, numerous lumps of sludge which had become loosened, but not thoroughly broken up and dispersed, had been carried to the pump-oil screen, plugging it completely.

In the second instance, a gasoline engine had become heavily coated with oil-oxidation sludges from extended operation with an unstable type of straight-mineral oil. Some of the deposits were of a grease-like consistency but there was also considerable granular material of the "coffee-grounds" type. Shortly after the addition of the first charge of heavy-duty oil, loss of oil pressure was noted. As in the previous example, the heavy-duty oil had loosened up considerable of the sludges from the lower engine surfaces and although the soft sludges were dispersed in the oil, the granular, "coffee-grounds" were carried to the oil screen and pump intake, causing almost complete plugging and cessation of oil flow.

In both of these experiences, it was fortunate that loss of oil pressure was noted in time that the engines could be shut down, otherwise serious engine damage would most probably have resulted.

Conclusions

The test results as reported in the preceding indicate that the essential function of heavy-duty oils should be defined as dispersancy rather than detergency. Although heavy-duty oils do display appreciable detergent properties on engine deposits of a soft, grease-like nature and on those parts of an engine where vigorous oil circulation and washing occurs, they are not effective cleansing agents for hard, adherent or baked deposits or in those engine sections where oil flow and attendent washing action is limited.

Furthermore, the detergent and loosening action of heavy-duty oils on soft sludges and deposits involves a serious hazard if adequate precautions are not taken. The sudden loosening of considerable amounts of sludges in badly fouled engines can readily cause plugging of oil-pump intakes and disruption of oil circulation. Serious engine damage can then result if the condition is not noticed soon enough. A sufficient number of such failures have occurred in the field to make this a problem which cannot be ignored.

Although heavy-duty oils have become popularly known as "detergent oils," it appears that a more correct description should be "dispersant oils." While no great harm results from the somewhat inaccurate name "detergent oil," it does seem desirable to emphasize that the essential function of heavy-duty oils is to keep clean engines in clean condition for maximum periods of operation. Since the only thorough and safe means of cleaning a badly fouled engine is by disassembly and overhaul, it likewise seems desirable to emphasize that heavy-duty oils are not intended as cleaning or purging agents, even though the popular name "detergent oil" might imply this function.

The apparent ability of heavy-duty oils to loosen soft, pasty type deposits from badly fouled engines, introduces a problem which may require serious consideration in postwar years. H. C. Mougey[3] has predicted that heavy-duty oils will become more widely available and will be used extensively for general passenger-car-engine lubrication when current restrictions on critical chemicals and additives are lifted.

The potential danger of sudden loosening of certain types of sludges when heavy-duty oils are first added to dirty engines is well recognized, and suitable precautions can be taken in most commercial-fleet operations where there is some measure of control over engine maintenance and lubrication practices. In the case of passenger cars, where owners frequently use different types or brands of oil with almost every oil addition or refill, there is no control over engine condition and the sludge loosening proclivities of heavy-duty oils thus presents a more serious problem than has been the case to date, where use has been confined largely to controlled-fleet operations.

REFERENCES

[1] Coordinating Research Council Test Designation L-1-1143. Coordinating Lubricants Research Procedure for determining in an engine the effect of engine oils on ring sticking, wear, and the accumulation of deposits.

[2] "Correlation of Laboratory Oil Bench Tests with Full-Scale Engine Tests." Report of Bench Test Group, Coordinating Lubricants Research Committee, Coordinating Research Council. SAE Journal (Transactions), Vol. 5, No. 2, pages 52-62 (Feb., 1943).

[3] "Hot Engine Sludge and Its Control," H. C. Mougey. Paper presented at the SAE Transportation and Maintenance Meeting, Philadelphia, June 28, 1944.

INDEX

PETROLEUM REFINER
1944 . . . Volume 23

Development, Technology, Processing and Plant Operation for Petroleum Refining and Natural Gasoline Manufacture

Page

Acetylene
Chemistry of Catalytic Hydropolymerization of Acetylene....Aug. 317
L. I. Antsus and A. D. Petrov. Translated by J. G. Tolpin

Accident Prevention
How to Organize and Conduct a Refinery Fire School.....Sept. 356
J. C. Watkins
Shell's Wood River Refinery Hangs Up New Safety Record..Sept. 130
J. F. Goldsberry
Safety With Hydrofluoric Acid Alkylation .....Dec. 469
A. W. Trusty

Additives
Chemistry in Petroleum .....Aug. 307
J. L. Franklin
Detergency or Dispersancy in Heavy Duty Engine Oils.....Dec. 504
Carl W. Georgi

Adsorbents
Pressure Drop for Flow Through Beds of Granular Adsorbents.July 247
H. V. Allen, Jr.

Alcohol
Spirit of the Times.....Jan. 19

Alkylation
Aviation Gasoline Plant Construction Will Be Completed in 1944 .....Jan. 1
Liquid-Phase Isomerization .....Feb. 61
Problems Confronting the Smaller Refineries.....July 241
R. G. Atkinson
Alkylation-Unit Pumping .....Aug. 283
Irving Taylor
Chemistry in Petroleum.....Aug. 307
J. L. Franklin
Texaco Adds 100-Octane Capacity at Los Angeles Works.....Oct. 397
Safety With Hydrofluoric Acid Alkylation.....Dec. 469
A. W. Trusty

Analytical
The Meaning of Freedom.....June 134
Dr. Willard H. Dow
Co-operative Movement Hits Petroleum Industry.....July 154
Time Saving Computing Instruments for Spectroscopic Analysis .....Sept. 343
T. D. Morgan and F. W. Crawford
The Growth Factor in Small Business.....Nov. 459
Earl P. Stevenson
The Future of Industrial Research as Seen by a Chemist...Nov. 137
Thomas Midgley, Jr.

Aviation Gasoline
Aviation Gasoline Plant Construction Will Be Completed in 1944 .....Jan. 1
The Genesis of a Giant.....Jan. 9
Robert P. Russell
Liquid-Phase Isomerization .....Feb. 61
An Informal Long-Range Forecast of Motor-Gasoline Developments .....Feb. 122
D. P. Barnard and R. F. Marschner
War Requirements Responsible for Refining Records.....March 130
Pan American Completes Aviation Gasoline Facilities....March 148
How Will the New Processes Affect the Postwar Light-Ends Situation? .....May 165
D. P. Barnard and J. H. Forrester
Economics of Natural-Gas Cycling Plants.....May 124
J. M. Flaitz
Problems Confronting the Smaller Refineries.....July 241
R. G. Atkinson
Chemicals From Petroleum.....July 259
H. D. Wilde
Chemistry in Petroleum.....Aug. 307
L. J. Franklin
Conversion of Thermal Cracking to the Cycloversion Process Oct. 363
A. E. Buell and P. M. Waddill
The Relation of Aviation-Fuel Quality to Engine Performance Oct. 383
W. J. Sweeney
Texaco Adds 100-Octane Capacity at Los Angeles Works...Oct. 397
Aircraft-Engine-Test Stand Completed at Bayway.....Oct. 136
Commercial Isomerization of Light Paraffins.....Nov. 423
B. L. Evering, N. Fragen and G. S. Weems
Humble Celebrates Delivery of Billion Gallons of Aviation Gasoline at Baytown .....Dec. 138

Boiler Feed
Economics of Combustion .....Jan. 23
Edwin L. Dennis
Boiler Feed Water Chemistry.....Aug. 311

Page

Buna Rubber
Styrene, Buna Rubber and Polystyrene.....March 87
W. C. Goggin

Burners—Oil and Gas
Economics of Combustion .....Jan. 23
Edwin L. Dennis

Butadiene
Port Neches Butadiene Plant Now on Stream.....March 83
Styrene, Buna Rubber and Polystyrene .....March 87
W. C. Goggin
Rubber Program Reaches Controversy and Confusion Stage March 122
War Requirements Responsible for Refining Records.....March 130
West Coast Synthetic Rubber Industry Unveiled.....May 192
E Pluribus Unum .....June 226
Chemicals From Petroleum .....July 259
H. D. Wilde
Chemistry of Catalytic Hydropolymerization of Acetylene....Aug. 317
L. I. Antsus and A. D. Petrov. Translated by J. G. Tolpin
Butane Dehydrogenation by the Houdry Process.....Nov. 409
R. C. Lassiat and F. D. Parker

Butane
Pressure Distillate Stabilizer and Butane Recovery Unit Come Out of Junk Heap.....Jan. 37
Progress of the Liquefied Petroleum Gas Industry in 1943..Jan. 124
G. G. Oberfell
Analysis of Butane-Isobutane Mixture.....Feb. 67
Alfred W. Francis
Improvised Tower Recovers Butane.....Feb. 55
Pumping Light Hydrocarbons.....April 117
Reuben G. Lovell
Application of Unit Operations to Fractionation and Other Vaporization Processes—Part 3.....April 139
R. L. Huntington
How Will the New Processes Affect the Postwar Light-Ends Situation? .....May 165
D. P. Barnard and J. H. Forrester
Combustible Gases as Substitute Motor Fuels.....June 235
Gustav Egloff and Mary Alexander
Butane Dehydrogenation by the Houdry Process.....Nov. 409
R. C. Lassiat and F. D. Parker

Butylene
How Will the New Processes Affect the Postwar Light-Ends Situation? .....May 165
D. P. Barnard and J. H. Forrester
Chemicals From Petroleum .....July 259
H. D. Wilde

Carbon Black
Carbon Black—Part 1 .....March 93
J. F. Gallie
Carbon Black—Part 2 .....April 149
J. F. Gallie
Science in Natural Gas.....Dec. 472
James E. Pew and Frank H. Dotterweich

Carbon Monoxide
Foreign Processes for the Conversion of Methane to Hydrogen and Carbon Monoxide .....Jan. 35
Heinz Heinemann

Catalysis
Aviation Gasoline Plant Construction Will Be Completed in 1944 .....Jan. 1
Synthesis of Gasoline From Carbon Monoxide and Hydrogen at Atmospheric Pressure .....Feb. 70
Franz Fischer
Maximum Hydrocarbon Utilizaton With Natural Gas as a Chemical Raw Material.....April 130
J. E. Pew and Frank H. Dotterweich
Operation of Synthetic Toluene Plant Made Public.....April 128
The Synthesis of Lubricants From the Fischer-Tropsch Process—Part 1 .....July 260
F. Fischer and H. Koch
What Takes Place in Polymerization.....July 253
Paul H. Faust
Problems Confronting the Smaller Refineries.....July 241
R. G. Atkinson
Alkylation-Unit Pumping .....Aug. 283
Irving Taylor
Chemistry of Catalytic Hydropolymerization of Acetylene..Aug. 317
L. I. Antsus and A. D. Petrov. Translated by J. G. Tolpin
Conversion of Thermal Cracking to the Cycloversion Process Oct. 363
A. E. Buell and P. M. Waddill
Butane Dehydrogenation by the Houdry Process.....Nov. 409
R. C. Lassiat and F. D. Parker

Page

Fischer-Tropsch Synthesis and the Gas Industry....Nov. 415
V. I. Komarewsky and C. H. Riesz
Safety with Hydrofluoric Acid Alkylation....Dec. 469
A. W. Trusty

Catalytic Cracking

Aviation Gasoline Plant Construction Will Be Completed in 1944....Jan. 1
The Genesis of a Giant....Jan. 9
Robert P. Russell
Study of the Effect of Catalytic Cracking on the Postwar Supply of Motor Gasolines, Distillates and Residual Fuels....March 111
Pan American Completes Aviation Gasoline Facilities....March 148
How Will the New Processes Affect the Postwar Light-Ends Situation?....May 165
D. P. Barnard and J. H. Forrester
Conversion of Thermal Cracking to the Cycloversion Process Oct. 363
A. E. Buell and P. M. Waddill
Texaco Adds 100-Octane Capacity at Los Angeles Works....Oct. 397
Butane Dehydrogenation by the Houdry Process....Nov. 409
R. C. Lassiat and F. D. Parker

Cetane Number

Influence of Ozone on Diesel Engine Performance....June 204
Walter J. Armstrong and Clark E. Thorp
Ignition Accelerators for Compression-Ignition Engine Fuels..July 272
J. S. Bogen and G. C. Wilson

Charts

Construction of Log-Log Charts....Aug. 296
Emory N. Kemler
How to Determine the Amount of Concrete Needed....Oct. 368
E. N. Kemler

Chemical Processing

Spirit of the Times....Jan. 19
Maximum Hydrocarbon Utilization With Natural Gas as a Chemical Raw Material....April 130
J. E. Pew and Frank H. Dotterweich

Chemical Treating

Unisol Treatment Effects Large Savings for Big West Oil Company....June 218
F. C. Moriarty

Combustion

Economics of Combustion....Jan. 23
Edwin L. Dennis

Compression

Centrifugal Compression of Hydrocarbon Gases....May 181
E. O. Bennett
The Combustion-Gas Turbine....May 171
F. K. Fischer and C. A. Meyer

Compressors

Centrifugal Compression of Hydrocarbon Gases....May 181
E. O. Bennett
Compressed Air Institute Urges More Complete Use of Compressor Auxiliaries....Jan. 32
Maintaining Wartime Compressors at Peak Operating Capacity....Feb. 78
Bruno Thiel

Condensation

Application of Unit Operations to Fractionation and Other Vaporization Processes—Part 1....Feb. 57
R. L. Huntington
Application of Unit Operations to Fractionation and Other Vaporization Processes—Part 2....March 107
R. L. Huntington
Application of Unit Operations to Fractionation and Other Vaporization Processes—Part 3....April 139
R. L. Huntington
Application of Unit Operation to Fractionation and Other Vaporization Processes—Part 4....May 188
R. L. Huntington
Application of Unit Operations to Fractionation and Other Vaporization Processes—Part 5....June 223
R. L. Huntington
Application of Unit Operations to Fractionation and Other Vaporization Processes—Part 6....July 269
R. L. Huntington
Application of Unit Operations to Fractionation and Other Vaporization Processes—Part 7....Aug. 301
R. L. Huntington
Process Design Procedure for Multicomponent Fractionators Sept. 321
C. G. Kirkbride
Application of Unit Operations to Fractionation and Other Vaporization Processes—Part 8....Sept. 351
R. L. Huntington
Application of Unit Operations to Fractionation and Other Vaporization Processes—Part 9....Oct. 400
R. L. Huntington
Application of Unit Operations to Fractionation and Other Vaporization Processes—Part 10....Nov. 451
R. L. Huntington
Application of Unit Operations to Fractionation and Other Vaporization Processes—Part 11....Dec. 499
R. L. Huntington

Construction

Aviation Gasoline Plant Construction Will Be Completed in 1944....Jan. 1
The Genesis of a Giant....Jan. 9
Robert P. Russell
Improvised Tower Recovers Butane....Feb. 55
Design of Foundations for Elevated Towers....Feb. 46
Samuel Garnett
Gas Transmission Practice....Sept. 359
Loring E. Heckman
Engineering and Construction of the Santa Maria Valley Absorption Plant....Sept. 347
D. E. McFaddin

Page

How to Determine the Amount of Concrete Needed....Oct. 368
E. N. Kemler

Cooling

Internal-Combustion Engine Cooling Improved Through Wind Tunnel....May 190

Cooling Water

Cooling-Water Systems and Their Chemical Treatment....Oct. 375
William A. Tanzola

Corrosion

Application of Nickel-Containing Corrosion-Resistant Alloys in the Petroleum Industry....May 186
B. B. Morton
Processing of West Texas Sour Crudes....Oct. 388
L. R. Gray

Cracking, Gas

Foreign Processes for the Conversion of Methane to Hyrdogen and Carbon Monoxide....Jan. 35
Heinz Heinemann

Cracking Plant

Processing of West Texas Sour Crude....Oct. 388
L. R. Gray

Crude Oil Analysis

Processing of West Texas Sour Crudes....Oct. 388
L. R. Gray

Cycling Plant Operation

Economics of Natural-Gas Cycling Plants....May 124
J. M. Flaitz

Dehydration

High-Pressure Dehydration Unit Conforms to Refinery Piping Code....Nov. 430
Harold F. Dawe and Henry N. Wade

Dehydrogenation

Butane Dehydrogenation by the Houdry Process....Nov. 409
R. C. Lassiat and F. D. Parker

Desalting

Processing of West Texas Sour Crudes....Oct. 388
L. R. Gray

Design

Design of Foundations for Elevated Towers....Feb. 46
Samuel Garnett
Maintenance of Electric Equipment Begins With Design..Aug. 292
Rayburn M. Hamilton
Process Design Procedure for Multicomponent Fractionators.Sept. 321
C. G. Kirkbride
Engineering and Construction of the Santa Mara Valley Absorption Plant....Sept. 347
D. E. McFaddin

Dewaxing

Oil Dewaxed and Wax Deoiled in Simultaneous Operation....June 230
Emil E. Ebner and F. T. Mertens

Diesel Fuel

Influence of Ozone on Diesel Engine Performance....June 204
Walter J. Armstrong and Clark E. Thorp
Ignition Accelerators for Compression-Ignition Engine Fuels..July 272
J. S. Bogen and G. C. Wilson
Motor Vehicle Power Plants and Transmission Line Units...Aug. 305
Robert Cass

Economics

PIWC Stresses Free Enterprise in Worldwide Oil Development....Jan. 132
Report on Lend-Lease Shows United States Biggest Oil User in War....Jan. 139
Aviation Gasoline Plant Construction Will Be Completed in 1944....Jan. 1
The Genesis of a Giant....Jan. 9
Robert P. Russell
Progress of the Liquefied Petroleum Gas Industry in 1943..Jan. 124
G. G. Oberfell
An Informal Long-Range Forecast of Motor-Gasoline Developments....Feb. 122
D. P. Barnard and R. F. Marschner
War Needs Spur Refineries on to All-Time High in 1943....Feb. 135
Estimated Consumption of Petroleum Products in the United States After the War....March 105
Study of the Effect of Catalytic Cracking on the Post-War Supply of Motor Gasolines, Distillates and Residual Fuels....March 111
Competitive Forces to Govern Petroleum or Alcohol Use in Synthetic Rubber Production....March 139
Economic Factors Affecting the Utilization of Natural Gas in the Southwest—Part 1....April 126
Clinton C. Randall and R. L. Huntington
How Will the New Processes Affect the Post-War Light-Ends Situation?....May 165
D. P. Barnard and J. H. Forrester
Natural Gas Will Supplement Crude Oil Reserves....May 146
Samuel F. Peterson
Status of the Natural Gasoline Industry....May 122
J. E. Pew
Economics of Natural-Gas Cycling Plants....May 124
J. M. Flaitz
Economic Factors Involved in Moving Natural Gas From Southwest—Part 2....May 127
C. L. Prokop and R. L. Huntington
Future Gas Supply Twice Known Reserves....June 130
Lyon F. Terry
Co-operative Movement Hits Petroleum Industry....July 154
Refinery Operations Near Capacity in Meeting Demand....Aug. 130
L. J. Logan

Page

Invention and the Oil Industry ..... Oct. 144
Gustav Egloff
Possibilities of Gasoline-Engine Development ..... Oct. 404
Forest S. Baster
Leveling of Demand Relieves Strain in Supplying Oil ..... Nov. 148
L. J. Logan

Electrical

Use of the Mass Spectrometer in the Routine Analysis of Refinery Gas Samples ..... April 123
J. G. Schaafsma
Refinery Operation Demands Effective Maintenance of Motor Starters ..... April 143
M. A. Hyde and L. E. Markle
Maintenance of Electric Equipment Begins With Design .. Aug. 292
Rayburn M. Hamilton
Time-Saving Computing Instruments for Spectroscopic Analysis ..... Sept. 343
T. D. Morgan and F. W. Crawford
The Automatic Electric Timer in Plant Operation ..... Dec. 461
J. J. Loustaunau

Electrical Installations

What Constitutes a Hazardous Area ..... July 244
G. G. Griffin

Electronics

The Electron Tube—Genie, Gremlin or Jeep? ..... Jan. 14
W. D. Cockrell

Engine Cooling

Controlled Water Jacket Cooling Reduces Maintenance Costs June 197
B. C. Thiel

Ethane

Combustible Gases as Substitute Motor Fuels ..... June 235
Gustav Egloff and Mary Alexander
Butane Dehydrogenation by the Houdry Process ..... Nov. 409
R. C. Lassiat and F. D. Parker

Fabrication

Design of Foundations for Elevated Towers ..... Feb. 46
Samuel Garnett
Improvised Tower Recovers Butane ..... Feb. 55
E Pluribus Unum ..... June 226
Process Design Procedure for Multicomponent Fractionators Sept. 321
C. G. Kirkbride
Engineering and Construction of the Santa Maria Valley Absorption Plant ..... Sept. 347
D. E. McFaddin
Adapting Old Equipment to New Uses ..... Nov. 455
Donald E. Evans and Walter B. Meyer

Filtration

Pressure Drop for Flow Through Beds of Granular Adsorbents. July 247
H. V. Allen, Jr.

Fire Fighting

How to Train Plant Personnel in Fire Prevention and Fire Fighting ..... May 159
A. W. Trusty
How to Organize and Conduct a Refinery Fire School ..... Sept. 356
J. C. Watkins
How Foam Conquers Fire ..... Oct. 395
F. S. Mabbatt
How Carbon Dioxide Conquers Fire ..... Nov. 447
H. V. Williamson

Fischer-Tropsch Process

Synthesis of Gasoline From Carbon Monoxide and Hydrogen at Atmospheric Pressure ..... Feb. 70
Franz Fischer
The Synthesis of Lubricants From the Fischer-Tropsch Process—Part 1 ..... July 260
F. Fischer and H. Koch
Recent Advances in Manufacture of Synthetic Lubricants From Kogasin ..... Aug. 312
F. Fischer, H. Koch, and K. Wiedeking
Fischer-Tropsch Synthesis and the Gas Industry ..... Nov. 415
V. I. Komarewsky and C. H. Riesz

Fluid Flow

Pressure Drop for Flow Through Beds of Granular Adsorbents. July 247
H. V. Allen, Jr.

Foreign

Report on Lend-Lease Shows United States Biggest Oil User in War ..... Jan. 139
Bombs Fall on Ploesti ..... March 113

Foundations

Design of Foundations for Elevated Towers ..... Feb. 46
Samuel Garnett
The Design of Ring Girders for Horizontal Tanks ..... June 207
A. C. Barton
How to Determine the Amount of Concrete Needed ..... Oct. 368
E. N. Kemler

Fractionation

Pressure Distillate Stabilizer and Butane Recovery Unit Come Out of Junk Heap ..... Jan. 37
Improvised Tower Recovers Butane ..... Feb. 55
Application of Unit Operations to Fractionation and Other Vaporization Processes—Part 1 ..... Feb. 57
R. L. Huntington
Application of Unit Operations to Fractionation and Other Vaporization Processes—Part 2 ..... March 107
R. L. Huntington
Application of Unit Operations to Fractionation and Other Vaporization Processes—Part 3 ..... April 139
R. L. Huntington
Application of Unit Operations to Fractionation and Other Vaporization Processes—Part 4 ..... May 188
R. L. Huntington

Page

Application of Unit Operations to Fractionation and Other Vaporization Processes—Part 5 ..... June 223
R. L. Huntington
Application of Unit Operations to Fractionation and Other Vaporization Processes—Part 6 ..... July 269
R. L. Huntington
An Old Tower Goes to a New Job ..... Aug. 300
Application of Unit Operations to Fractionation and Other Vaporization Processes—Part 7 ..... Aug. 301
R. L. Huntington
Process Design Procedure for Multicomponent Fractionators. Sept. 321
C. G. Kirkbride
Application of Unit Operations to Fractionation and Other Vaporization Processes—Part 8 ..... Sept. 351
R. L. Huntington
Texaco Adds 100-Octane Capacity at Los Angeles Works ..... Oct. 397
Application of Unit Operations to Fractionation and Other Vaporization Processes—Part 9 ..... Oct. 400
R. L. Huntington
Application of Unit Operations to Fractionation and Other Vaporization Processes—Part 10 ..... Nov. 451
R. L. Huntington
Application of Unit Operations to Fractionation and Other Vaporization Processes—Part 11 ..... Dec. 499
R. L. Huntington

Fuel Testing

Aircraft-Engine-Test Stand Completed at Bayway ..... Oct. 136
The Relation of Aviation-Fuel Quality to Engine Performance Oct. 383
W. J. Sweeney

Furnace Black

Carbon Black—Part 1 ..... March 93
J. F. Gallie
Carbon Black—Part 2 ..... April 149
J. F. Gallie

Furnaces

Economics of Combustion ..... Jan. 23
Edwin L. Dennis

Gas Turbine

The Combustion-Gas Turbine ..... May 171
F. K. Fischer and C. A. Meyer
Centrifugal Compression of Hydrocarbon Gases ..... May 181
E. O. Bennett

Gas Measurement

An Improved Meter for the Measurement of Gas Flow Rates ..... March 115
W. G. Appleby and W. H. Avery

Hazards

What Constitutes a Hazardous Area ..... July 244
G. G. Griffin
Safety With Hydrofluoric Acid Alkylation ..... Dec. 469
A. W. Trusty

Hydraulics

Pressure Drop for Flow Through Beds of Granular Adsorbents. July 247
H. V. Allen, Jr.
Alkylation-Unit Pumping ..... Aug. 283
Irving Taylor

Hydrocarbon Specifications

Solubility of Water in Liquid Hydrocarbons ..... May 170

Hydrogen

Foreign Processes for the Conversion of Methane to Hydrogen and Carbon Monoxide ..... Jan. 35
Heinz Heinemann

Hydrogenation

Synthesis of Gasoline From Carbon Monoxide and Hydrogen at Atmospheric Pressure ..... Feb. 70
Franz Fischer

Inhibitors

Thiophenol in Cracked Gasoline ..... Feb. 41
G. S. Windle

Instrumentation

Time-Saving Computing Instruments for Spectroscopic Analysis ..... Sept. 343
T. D. Morgan and F. W. Crawford
Characteristics of the Differential Type Flow Meter and Conditions Affecting Its Operation—Part 1 ..... Oct. 370
L. K. Spink
Characteristics of the Differential Type Flow Meter and Conditions Affecting Its Operation—Part 2 ..... Nov. 433
L. K. Spink
Characteristics of the Differential Type Flow Meter and Conditions Affecting Its Operation—Part 3 ..... Dec. 488
L. K. Spink
The Automatic Electric Timer in Refinery Processing ..... Dec. 461
J. J. Loustaunau

Internal Combustion Engine

Internal-Combustion Engine Cooling Improved Through Wind Tunnel ..... May 180
Controlled Water Jacket Cooling Reduces Maintenance Costs ..... June 197
B. C. Thiel
Influence of Ozone on Diesel Engine Performance ..... June 204
Walter J. Armstrong and Clark E. Thorp
Ignition Accelerators for Compression-Ignition Engine Fuel July 272
J. S. Bogen and G. C. Wilson

Iso-Butane

Analysis of Butane-Isobutane Mixture ..... Feb. 67
Alfred W. Francis
Combustible Gases as Substitute for Motor Fuels ..... June 235
Gustav Egloff and Mary Alexander
Butane Dehydrogenation by the Houdry Process ..... Nov. 409
R. C. Lassiat and F. D. Parker

Page

Taxation
Co-operative Movement Hits Petroleum Industry....July 154

Testing
Test Pressure and Safe Dimensions of Welded Pressure Vessels....April 135
H. F. Lassner

Tetra Ethyl Lead Response
Thiophenol in Cracked Gasoline....Feb. 41
G. S. Windle

Thermal Black
Carbon Black—Part 1....March 93
J. F. Gallie

Thermal Cracking
Shortening Up on Down Time....Aug. 290
Processing of West Texas Sour Crudes....Oct. 388
L. R. Gray

Thermal Reforming
Conversion of Thermal Cracking to the Cycloversion Process..Oct. 363
A. E. Buell and P. M. Waddill

Thiophenol
Thiophenol in Cracked Gasoline....Feb. 41
G. S. Windle

Toluene
War Requirements Responsible for Refining Records....March 130
Operation of Synthetic Toluene Plant Made Public....April 128
Chemistry in Petroleum....Aug. 307
J. L. Franklin

Topping Plant
Processing of West Texas Sour Crudes....Oct. 388
L. R. Gray

Tower Design
Process Design Procedure for Multicomponent Fractionators.Sept. 321
C. G. Kirkbride

Towers
Design of Foundations for Elevated Towers....Feb. 46
Samuel Garnett

Treating—Chemical
Thiophenol in Cracked Gasoline....Feb. 41
G. S. Windle
Unisol Treatment Effects Saving for Big West Oil Company..June 218
F. C. Moriarty

Treating—Water
Boiler Feed Water Chemistry....Aug. 311
Cooling-Water Systems and Their Chemical Treatment....Oct. 375
William A. Tanzola

Page

Tube Cleaning
Shortening Up on Down Time....Aug. 290

Vaporization
Application of Unit Operations to Fractionation and Other Vaporization Processes—Part 1....Feb. 57
R. L. Huntington
Application of Unit Operations to Fractionation and Other Vaporization Processes—Part 2....March 107
R. L. Huntington
Application of Unit Operations to Fractionation and Other Vaporization Processes—Part 3....April 139
R. L. Huntington
Application of Unit Operations to Fractionation and Other Vaporization Processes—Part 4....May 188
R. L. Huntington
Application of Unit Operations to Fractionation and Other Vaporization Processes—Part 5....June 223
R. L. Huntington
Application of Unit Operations to Fractionation and Other Vaporization Processes—Part 6....July 269
R. L. Huntington
Application of Unit Operations to Fractionation and Other Vaporization Processes—Part 7....Aug. 301
R. L. Huntington
Process Design Procedure for Multicomponent Fractionators.Sept. 321
C. G. Kirkbride
Application of Unit Operations to Fractionation and Other Vaporization Processes—Part 8....Sept. 351
R. L. Huntington
Application of Unit Operations to Fractionation and Other Vaporization Processes—Part 9....Oct. 400
R. L. Huntington
Application of Unit Operations to Fractionation and Other Vaporization Processes—Part 10....Nov. 451
R. L. Huntington
Application of Unit Operations to Fractionation and Other Vaporization Processes—Part 11....Dec. 499
R. L. Huntington

Vessels
Design of Foundations for Elevated Towers....Feb. 46
Samuel Garnett
The Design of Ring Girders for Horizontal Tanks....June 207
A. C. Barton

Water Systems
Cooling-Water Systems and Their Chemical Treatment....Oct. 375
William A. Tanzola
Maintaining Wartime Compressors at Peak Operating Capacity....Feb. 78
Bruno Thiel

Welding
Wooden Core in Storage Reel Protects Welding Cable....Feb. 77
Adapting Old Equipment to New Uses....Nov. 455
Donald E. Evans and Walter B. Meyer

Monthly Editorial Features

Page

Advertisers' Index
January 222
February 246
March 254
April 262
May 254
June 270
July 254
August 270
September 254
October 302
November 286
December 286

Business Notes
January 211
February 230
March 238
April 252
May 244
June 256
July 244
August 262
September 242
October 286
November 274
December 276

Catalog and Bulletins
January 219
February 243
March 251
April 261
May 253
June 269
July 251
August 267
September 251
October 299
November 283
December 285

Digest of U. S. Patents
Heinz Heinemann
On Catalytic Hydrogenation of Hydrocarbons....Jan. 154
On Polymerization....Feb. 142
On Dehydrogenation and Dehydrohalogenation of Hydrocarbons....April 142

Page

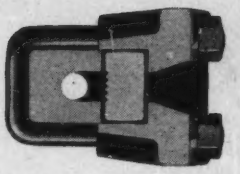
On Alkylation of Hydrocarbons....May 164
On Desulfurization....June 150
Recovery and Processing of Natural Gas and Its Constituents and on Hydrocarbon Synthesis....July 172
On Isomerization....Aug. 154
On Catalytic Aromatization and Cyclization....Oct. 176
On Hydrogenation and Halogenation....Nov. 182

The Look Box
January 81
February 81
March 81
April 81
May 81
June 81
July 83
August 83
September 83
October 79
November 81
December 77

New Equipment
January 202
February 218
March 226
April 242
May 226
June 250
July 226
August 256
September 226
October 278
November 270
December 270

Science and Technology by E. S. Leslie and H. B. Coates
January 166
February 150
March 168
April 164
May 176
June 173
July 186
August 172
September 174
October 184
November 196
December 190

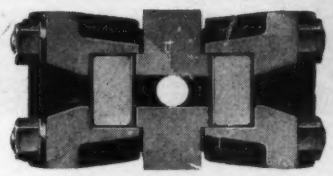
Alike in Quality



PENBERTHY *Reflex*
DROP FORGED STEEL
LIQUID LEVEL GAGES

Liquid shows black—empty space shows white. Preferred wherever liquid level must be easily and positively visible... and when liquids are under high pressure or at high temperature.

These gages are made of alloy temperature resisting steel and are the highest quality throughout. Liquid chamber is made from a solid block of steel to assure perfect alignment and rigidity. All Penberthy gages conform with A.P.I.-A.S.M.E. requirements.



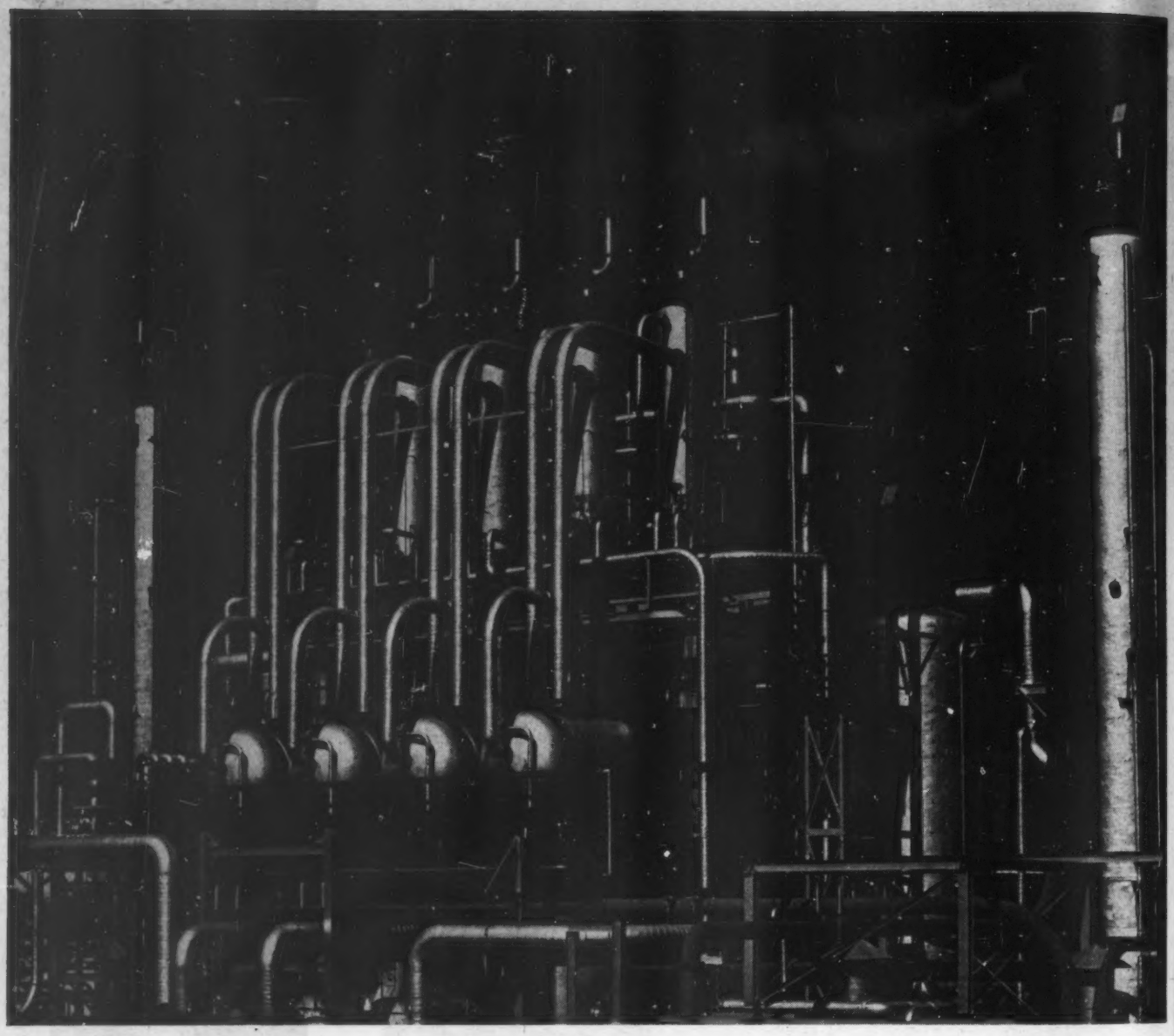
PENBERTHY
Transparent
DROP FORGED STEEL
LIQUID LEVEL GAGES

Used to observe color and density of liquids under high pressures, and/or temperatures. Construction is exceptionally rugged . . . similar to Reflex types.

PENBERTHY INJECTOR CO.

DETROIT, MICHIGAN • Canadian Plant; Windsor, Ontario

PENBERTHY PRODUCTS



Humble Celebrates Delivery of Billion Gallons of Aviation Gasoline By Refinery at Baytown

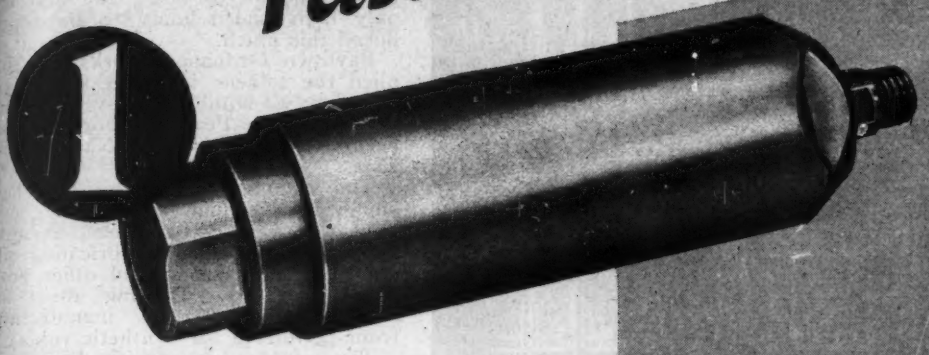
CELEBRATING delivery of one billion gallons of 100-octane gasoline by its Baytown refinery, Humble Oil & Refining Company gave all credit to its manpower—from research executives to the roughnecks in the fields, and for twenty-five years back to the beginning of the organization.

Highlight of the celebration at the refinery, which was so arranged that workers and their families had prominent participation, was formal delivery by H. C. Wiess, president of the company, of the billionth gallon of 100-octane to a representative of the War Department. This ceremony was in the presence of state and national government officials and leaders in industry.

THE PICTURE shows a section of a hydrogenation unit constructed recently to improve base stocks for 100-octane gasoline at Baytown. This unit formerly was an old Cross Coil and was converted to hydrogenation to increase products needed for war.

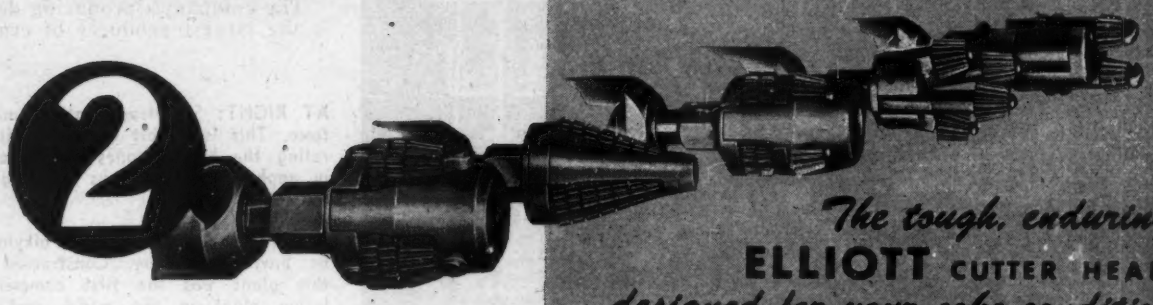
A bronze medal commemorating the event was presented to 14,000 active employes, and more than 3000 on military leave, in a special book which contained a message from the company's management expressing appreciation for the contribution each worker has made

RECIPE FOR Faster Tube Cleaning-



1

The new powerful, record-making
ELLIOTT
1100 SERIES MOTOR



2

The tough, enduring
ELLIOTT CUTTER HEAD
designed for your coke condition

3

The time-saving, quick-acting
ELLIOTT FOOT THROTTLE VALVE
that works like an accelerator

Add to these ingredients, the Elliott Automatic Lubricator, and Elliott operating hose and couplings, and find new freedom from cleaner failure and delays, and new satisfaction in a fast job, well done.

If not sure of the right Elliott cutter-motor combination for your coke condition, call upon the glad cooperation of the Elliott tube cleaning engineer in your territory. Write us.

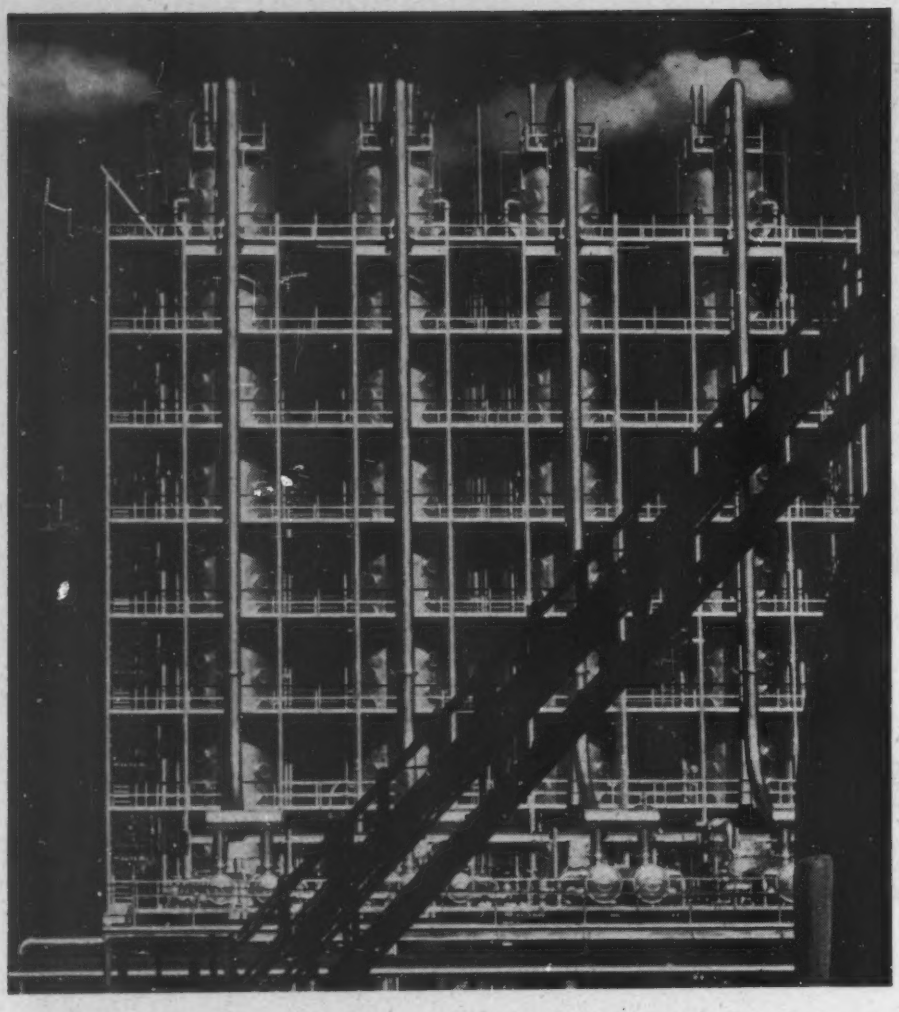
New tube cleaning bulletin Y-13 just published. It's a new kind of fact-giving manual. It's valuable. Mailed at your request.

Y-234

ELLIOTT COMPANY

Tube Cleaning Headquarters

SPRINGFIELD, OHIO • DISTRICT OFFICES IN PRINCIPAL CITIES



toward the establishment of war-production records. Another booklet, telling in pictures and story the accomplishments of the several departments of the company was furnished to each employe. This booklet detailed these as the company's war accomplishments:

Attainment of the billion-gallon record in the manufacture of finished 100-octane gasoline gives Baytown refinery the distinction of being the first and only individual refinery to have produced this much.

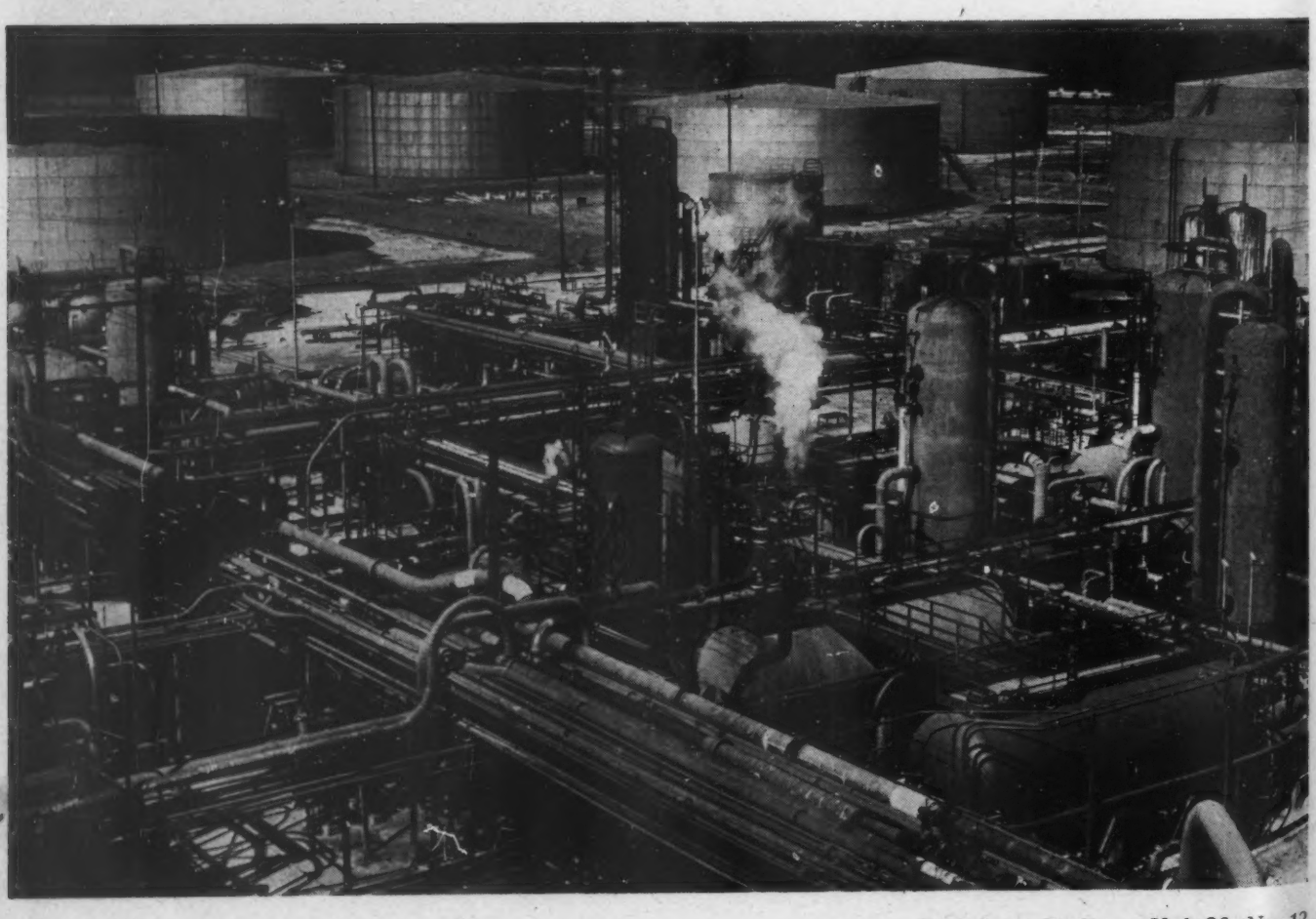
Baytown Ordnance Works has supplied the toluene for at least one out of every two bombs used by the United Nations since Pearl Harbor, and has been awarded the Army-Navy E five times.

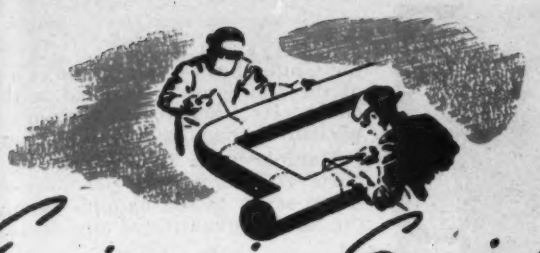
The company's refineries also have supplied large quantities of other aviation and military gasolines, aviation-engine and heavy-duty lubricating oils, Navy special fuel oil, and other products. They are supplying about one sixth of the materials manufactured from petroleum for synthetic rubber.

The company's producing department is the largest producer of crude oil in

AT RIGHT: Superfractionating unit at Baytown. This is a sort of octane sifter, separating the high octanes from the low ones in naphthas from various cracking processes.

BELOW: A section of the alkylation plant at Baytown refinery. Constructed in 1938, this plant was the first commercial alkylation plant in the world, and has been in great measure responsible for Humble Oil & Refining Company's large production of the gasoline for the fighting planes.





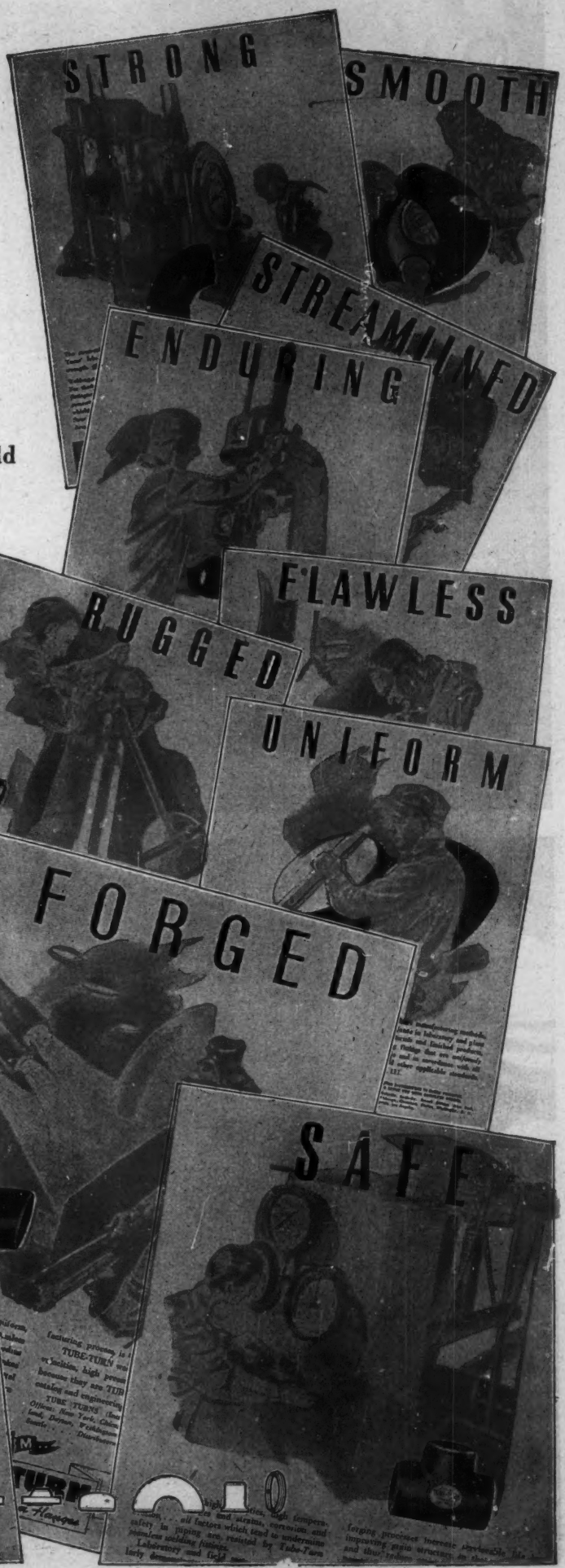
Engineering Serial

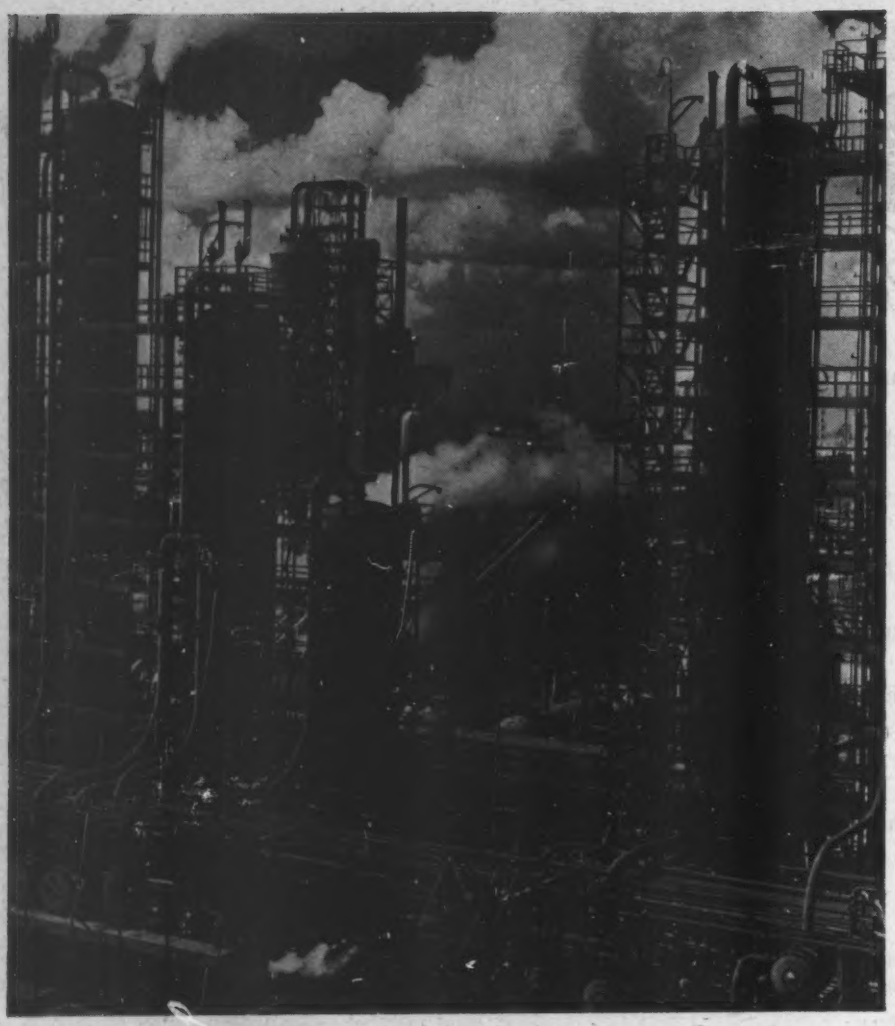
Each month, during the past year, Tube Turns' advertisements have pointed out one single outstanding advantage of Tube-Turn seamless welding fittings. Added together, they have told a serial story of Tube-Turn engineering and performance qualities that are of prime importance to everyone concerned with designing, specifying, buying or installing piping and fittings.

Selected Tube Turns Distributors in every principal city are ready to serve you from complete stocks.

TUBE TURNS (Inc.) Louisville, Kentucky. Branch Offices: New York, Chicago, Philadelphia, Pittsburgh, Cleveland, Dayton, Washington, D. C., Houston, San Francisco, Seattle, Los Angeles.

TUBE-TURN
TRADE MARK
Welding Fittings and Flanges





the United States, and produces a fourth of the additional oil needed in the war effort. Its current production is one twelfth of the total for this country.

Humble Pipe Line Company transports 700,000 barrels per day—one in every seven of the nation's supply, and the largest quantity of any one system.

Baytown Biggest

Baytown refinery is on Houston Ship Channel 25 miles below Houston, and normally moves most of its output by tanker. Currently processing over 200,000 barrels of oil per day, it is rated the largest plant in the United States, processing 4 percent of the country's crude oil. During the emergency four government projects have been designed and built by the company and are operated by it for the government, as parts of the original refinery. These include the toluene plant, a hydrogenation unit recently completed, a butadiene plant which provides raw material for Buna-S rubber made at an adjacent copolymer plant, and a butyl rubber plant which produces finished rubber. Nearly 6000 men and women are employed in these operations.

AT RIGHT, in the foreground, can be seen a portion of the superfractionation unit at Baytown, with spheroid tanks and fluid-catalytic-cracking unit in the background.

BELOW is a view of the tank-car loading department at Baytown, giving an idea of the number of cars required. Normally the bulk of the plant output moves in tankers.

ONE REASON WHY MEN WHO KNOW COMPRESSORS BEST PREFER GMV's

Cooper-Bessemer GMV compressors are built for heavy-duty jobs in the oil and gas fields, refineries, gasoline plants, gas distribution stations, pressure maintenance, re-pressuring, and re-cycling plants.

To give 100% performance under continuous loads, every part from base to automatic controls is designed and built to meet the most severe operating conditions—backed by the knowledge and skill of men who have been building compressors for more than thirty years.

Some important factors in the GMV's rugged strength are:

1. Meehanite Metal with its unusual strength, uniformity, and freedom from internal weaknesses is used for all parts which would normally be made of cast iron.
2. The shorter, "V"-engine crankshaft is more rigid. In the GMV, exceptionally high diameter-to-length ratio makes it all the more rugged and immune to torsional stresses.
3. Two precision-type main bearings for each crankthrow afford maximum load bearing surface and optimum load distribution.
4. The GMV articulated connecting rod design combines each compressor rod and pair of power rods into an unusually rugged, well-balanced unit assembly.
5. A patented saddle-end piston pin construction, with full-length solid bronze bearings, provides twice the bearing area otherwise possible.
6. Honed power cylinders and plated pistons are of wear-resisting Meehanite.
7. Low and medium pressure compressor cylinder bodies are of high-strength Meehanite and cast steel respectively. High pressure bodies are forged steel.
8. Incorporated into one strong, simple design, the scavenging air header, oil sump and air intake are all cast within the engine base.

by **Cooper-Bessemer**

MOUNT VERNON, OHIO and GROVE CITY, PENNA.

Houston, Dallas, Greggton, Pampa and Odessa, Texas · Shreveport · St. Louis · Los Angeles

New Developments in Petroleum Research

J. K. ROBERTS
Director of Research, Standard Oil Company (Indiana)

RESEARCH is a critical and exhaustive investigation or experimentation having as its aim the acquisition of new knowledge or the revision of accepted conclusions in the light of newly discovered facts. Research embodies both pioneering beyond the frontiers of knowledge and the reduction to practice of newly-won information. For example, the research of Pasteur established the fundamental mechanism by which bacteria would infect the body's system, but after Pasteur, however, the laborious researches of a multitude of other workers were required in order to develop adequate ways and means for putting his basic findings into practical use. Research is frequently thought of as something mysterious which ordinary people cannot understand, or possibly as something like vitamin pills, which constitute relatively minor and harmless expenditures but which may do a world of good. Actually, research has become as much a part of modern business enterprise as manufacturing, sales and accounting.

I shall cover the three phases of research currently most important to the petroleum industry: First, contributions of research to the war effort; second, the place of research in attacking critical postwar problems; and third, long-range research. However, before proceeding with this detailed development, I believe it advisable to remind you of several notable examples of industrial research as it has always been applied in the petroleum industry. These are:

1. The discovery of the principle of cracking of petroleum hydrocarbons and the subsequent development of practical procedures by Dr. William Burton of Standard Oil Company (Indiana).

2. The discovery by Dr. Thomas Midgely of the possibility of suppressing knocking in the internal-combustion engine, the use of anti-knocks, and the final application to practice through the development of lead tetraethyl and Ethyl fluid.

3. The discovery of the effectiveness of isooctane as a non-knocking fuel, and the subsequent development of practical means for manufacturing it in large quantities by such processes as alkylation and selective polymerization plus hydrogenation.

4. The discovery of geophysical means for locating crude oil and the subsequent development of the necessary instrumentations for their practical use.

5. Discovery of means for converting gaseous hydrocarbons or coal to liquid oils and the subsequent development of practical applications of the Fischer process. (This development is still in its early stages, but its commercial success appears assured.)

With the foregoing examples in mind, we can now review some of the contributions of research in the petroleum industry which have already been made and indicate a few of the most important opportunities for petroleum industry research in the immediate future.

TWO subjects from the program of the National Industrial Chemical Conference in Chicago, November 14 to 19, dealt with phases of petroleum refining. The conference was a part of the National Chemical Exposition, which is sponsored by the Chicago section of the American Chemical Society.

Dr. J. K. Roberts, director of research, Standard Oil Company (Indiana), was one of the speakers at the luncheon November 15, held jointly with the Chicago Association of Commerce, his subject being, "New Developments in Petroleum Research."

The program of the evening of November 16 was on the general subject "Achievements of the Chemical Engineer," and Dr. George Granger Brown, University of Michigan had a paper, "The Chemical Engineer in the Petroleum Industry."

Probably the most dramatic illustration of the contribution of research in the petroleum industry to the war effort is offered by the case of 100-octane gasoline. By now, virtually everyone realizes that the availability of this fuel in vast quantities is, to a considerable extent, responsible for the success of the Allies' modern military aviation. However, few people stop to ask the question, "How much 100-octane gasoline is there in crude oil and how is it extracted?" The answer is a little startling. There is no 100-octane number gasoline in crude. The basic ingredients for this vital war material are made by chemical synthesis methods (artificially created) using certain petroleum fractions as raw materials. Prior to the start of the war effort, the total United States production of 100-octane gasoline was about 25,000 barrels per calendar day. Currently it is produced at at least 20 times that rate, which should give a pretty good idea of the tremendous scale upon which the researches into isooctane as a high anti-knock material have been applied to actual production. If it were not for this contribution of research to the manufacture of high-performance aviation fuel, the Allied air services would be restricted to about one fifth as much aviation gasoline as they are now receiving and that gasoline would give only about three quarters of the engine performance made possible by 100-octane fuel. You all probably have seen, from time to time, illustrations depicting the superiority of 100-octane fuel over the older varieties of gasoline. These illustrations show that much greater bomb loads can be carried longer distances or that fighters can fly higher and faster and so on. It will suffice, for the purpose of this discussion, merely to state that many of the most important tactical aircraft now in use on our fighting fronts cannot be operated at all on a fuel of less than 100-octane while the usefulness of the others would be so impaired as to make impossible such military operations as bombing of industries deep inside of Germany, the expeditions of the 20th Air Force's B-29's, and the devastating and decisive air-sea battle west of Saipan about three months ago, and the more recent battle of the Philippine Sea. Research is, of course, seeking out still better fuels. Perhaps many of you have noticed recently released publicity to the effect that a much higher performance aviation fuel will be made available for use against Japan as soon as the termination of the European war releases the necessary facilities. And, last but not least, as added emphasis to the grand scale of this application of research to the war effort, it should be pointed out that the petroleum industry has spent in excess of three quarters of a billion dollars to increase the production of synthetic components of the 100-octane fuels alone.

Smaller, less spectacular, but nonetheless very important to the war effort, is the manufacture of toluene from petroleum. In World War I the production of toluene from coking of coal was pushed to an extent which at that time staggered the imagination. Today, toluene is being produced in quantities exceeding World War I production by tenfold, with practically all of it being made by synthetic procedures from petroleum, a possibility scarcely dreamed of at the time of World War I. Modern mass bombing and the use of large caliber artillery would not be possible without the availability of toluene for TNT in quantities far greater than any hope of the by-product coking industry to provide.

Chemically, the procedure for making toluene consists of two principal steps. The first of these steps converts a particular component of crude oil into an impure mixture of materials containing a considerable amount of toluene. The second step consists of a most precise chemical extraction procedure which separates the toluene from the other material in the very high degree of purity required for nitration.

Future of Synthetic Rubber

The contributions of research to solving the rubber shortage problem are, of course, in the front of everyone's mind and to go into detail here would be simply boring you with repetition. I merely wish to point out that one vital material required in the manufacture of the Buna-S type synthetic rubber used for tires is made by chemical synthesis procedures from material obtained from crude petroleum. Buna rubber basically consists of the reaction product of butadiene and styrene. The latter is

most conveniently made by reacting benzol, a by-product of coking coal, with an unsaturated gas obtained in the course of refining petroleum, namely, ethylene. The butadiene, however, is not available as a by-product from any other process. Large quantities currently are made from alcohol, but the petroleum industry must also furnish very large amounts and, further, must continue to furnish even increasing quantities if synthetic rubber is to remain as an established product. The manufacture of butadiene in the quantities required has imposed many particularly difficult problems. These are now sufficiently well in hand that the supply of butadiene from petroleum is going forward at a gratifying rate, and I am willing to venture the prediction that its manufacture will continue to be a major activity from now on.

Special Lubricants

Petroleum research also has contributed to other less spectacular but very important developments in the war effort. These include lubricating oils especially adapted to the requirements of submarine, and other highly specialized diesel engines for the Navy, heavy-duty motor oils required for the operating of tanks and military trucks, and corrosion preventives for a wide variety of services—including engine lubricating oils—which are required to protect equipment against the ravages of salt water and tropical humidity. The hydraulic systems used in the modern high-altitude military airplane require oils to cope with the wide temperature ranges encountered which may vary from the blistering heat of the desert to the extreme sub-zero temperatures of the stratosphere in a single flight. The same considerations hold for instrument oils, while one of the more difficult technical problems has involved the development of greases for the galaxy of small anti-friction bearings used in the accessories of the modern bomber, which must operate freely at temperatures below −60° F. It can be seen, therefore, that petroleum research for war takes many and varied forms.

We at home are most conscious, of course, of the quantity aspects of war demand which have resulted in shortages of almost every type of petroleum product. Here again, research has been called upon to do its utmost to increase the capacity of every element of petroleum production, refining and transportation. That it has been at least partly successful is attested by the tremendous increase in production, particularly of the most critical products, far beyond the estimates of even the most rash prewar optimist. When it is realized that the current production of 100-octane gasoline is about one third of the prewar production of gasoline of all kinds, and when we consider other tremendous increases due to the military requirements, it is a wonder that there is anything left for the strictly civilian automobile driver. I wish it were possible to predict the early availability of unlimited gasoline for the "A"-card driver. However, it has been frequently emphasized that this is a petroleum war. These are no idle words, as even in spite of today's tremendous increases in the output of all petroleum products, many of our activities against the enemy must still be proportioned to the availabiilty of gasoline and other fuels. The termination of demands from one war theater may release fuel from that theater, but it is most probable that such fuel can be used effectively elsewhere. It appears, therefore, that petroleum products, particularly the gasolines, must remain critical until after final V-day.

Postwar Petroleum Research

As might be expected, the petroleum industry is faced with a number of immediate postwar problems which at times seem to be only a shade less urgent than those of war research. One of these problems is foremost in the minds of a very large number of people, namely, "What becomes of 100-octane gasoline after V-Day?" Superficially, the answer to this question is quite simple—it simply will not be made beyond the comparatively small quantities required for postwar operations. To the petroleum economist and technologist, however, this is a far from satisfactory answer. Actually, the facilities now employed for the manufacture of 100-octane gasoline must be converted as rapidly as possible to the manufacture of motor gasoline. The principal reason for this is that present wartime operations are punishing to the industry's program for efficient crude production and efficient utilization of crude. The industry must return to more efficient operations as rapidly as possible. The catalytic-cracking units and many of the other processes now being operated to produce the maximum amounts of 100-octane gasoline must be altered and their operations tied in with the rest of the refining procedures for the purpose of obtaining maximum yields of motor gasoline. Refining operations have been so completely distorted by the necessities of war production programs that a large amount of technical effort will be required in order to restore a balanced peacetime schedule of operations. The country is fortunate that the petroleum industry is able to use the same basic equipment for both peacetime and wartime production. However, we can expect more emphasis than ever before will be placed on the necessity for securing the greatest number of car miles per barrel of crude and that a major portion of the research effort will be devoted to solving the multitude of problems to be encountered in the conversion of war-built equipment for that purpose.

Other problems of a more strictly research and development nature are known to face us as soon as the war ends. For example, it seems fairly evident that postwar car designs will embody the general use of automatic transmissions. Lubricant requirements for these devices are different from the older and more conventional forms. Just where these designs will lead us we do not as yet know, but we can only anticipate that research and development of lubricants in the petroleum industry must be coordinated with the developments of the automobile industry. The use of petroleum as a source of raw materials for the manufacture of chemicals and synthetic rubber and plastics is often discussed. It is not now possible to predict the courses of these activities, but it appears that petroleum research will from now on be very busy in these fields.

The research and development problems considered so far are of immediate war emergency or bread-and-butter types. The term "petroleum research" is also applied to the attack on problems which, while nonetheless important to national defense and economics, are of a long range nature. Research into the methods of crude discovery occupies, of course, a top place in the list of such problems. As has been pointed out from time to time since the drilling of the Drake well more than 80 years ago, the country has always been in imminent danger of running out of crude. Before the war, research developed new techniques for finding oil often enough to more than keep up with the increasing demand. Wartime exigencies have virtually stopped all such effort, with the result that during the past few years demand has far outstripped discovery. Obviously, therefore, research effort on means for finding oil must be resumed with renewed vigor as soon as possible. Another golden opportunity for research lies in the field of increasing the efficiency of production of crude already discovered and particularly in the development of procedures for secondary production. This latter term implies the production of crude known to be in the ground but not economically obtainable by existing procedures. For example, a large proportion of the crude producible by existing means has been secured by the Pennsylvania oil fields. This represents only a small fraction, however, of the amount known to be in the ground. Research in the utilization of our enormous natural gas production promises to be well worth while. Much effort is being devoted to application of the so-called "Fischer" process to the manufacture of liquid hydrocarbons from natural gas. No actual large-scale manufacture based on this process is as yet in operation, but the work has been carried to the point where commercially practical processes are assured. Other long-range researches intended to increase the supply contemplate the development of petroleum substitutes, as by reduction of tar sands and shale and the conversion of coal to oil. The technology of such processes has been pushed far enough to prove that they are technically sound and workable. The substitutes simply cannot compete economically with petroleum and natural gas at present but a comparatively small increase in the refinery cost of gasoline would place some of these processes in a favorable light. Long before the nation runs out of gasoline due to petroleum shortage, an increase in price of five cents a gallon of gasoline will bring liquefaction of coal (hydrogenation) into the picture along with its virtually limitless supply of the basic raw material.

The close relation of research to the actual operation of the petroleum industry currently, and for the longer range view, is evident from the types of problems engaging the attention of research men. (Research still is a relatively small activity, far smaller in relation to the size of the petroleum industry than, for example, research in the chemical industry.) It is to be expected that as time goes on still vaster opportunities for research will unfold. Its part in the petroleum industry must continue to grow if the industry is to make its rightful contribution to the advancement of American living standards.

LUBE OILS--100 V.I. with -10°F. POUR POINT

COMPLETE PLANTS FOR -

Vacuum Distillation
Propane Deasphalting
Furfural Refining

Solvent Dewaxing
Wax Manufacturing
Clay Finishing

FW

FOSTER

Chemical Engineer in Petroleum Industry

GEORGE GRANGER BROWN
University of Michigan

THE secretive non-cooperative attitude of the early industry was rapidly replaced by a spirit of cooperation with the organization of the American Petroleum Institute in 1919. The first truly chemical engineering text by Walker, Lewis and McAdams of Massachusetts Institute of Technology appeared in 1923 and clearly laid the foundation to "stimulate engineers to design apparatus adapted for any particular purpose rather than just to build it and then to rely upon large-scale experimentation with extensive changes in construction to effect efficient operation." The activities of the technical societies and associations in which chemical engineers from different industries discussed their various problems aided in the rapid development and adaptation of new methods in the petroleum industry which had been found satisfactory and valuable in other fields. The meetings of the American Petroleum Institute in which oil men got together stimulated the distribution of the knowledge of these operations throughout the industry. As a result fractionating columns which were introduced to the petroleum industry at about this time by chemical engineers who were familiar with this equipment from their studies of the alcohol industry were rapidly adopted throughout the industry.

With the old simple batch distillation it was necessary to rerun some distillates (those intermediate to the desired products) hundreds of times in order to fractionate them into products meeting specifications. This rerunning of the slop cuts was not only a serious expense but a limitation to the capacity of the plant. The use of a fractionating column and the accompanying sharp separation between the various desired fractions made it possible to eliminate this type of rerunning. The fractionating columns were used in various ways. At first a number of shell stills were hooked into a single column with the vapor streams introduced at what was considered to be appropriate locations therein. This was shortly displaced by fractionating columns on individual shell stills and the stills hooked together in the form of a continuous battery. This type of operation continued for some years and many such batteries have been operated until they almost fell apart.

The difficulty of heating the heavy asphaltic oils of the West Coast in shell stills because of coke formation and over-heating of the metals was eliminated by competent engineers who appreciated at least the basic principles of heat transfer to fluids and introduced the continuous pipe still.

At first radiant heat was not well understood. The early designers being afraid of radiant heat exposed only a small area of the tubes to radiant heat and depended mainly upon heat transfer by convection from circulating gases. This is the most unsatisfactory way to use radiant heat where mild conditions are desired, as large heat-absorbing surfaces decrease the intensity of the radiant heat, as we soon found out from many furnace studies which have contributed to the knowledge of the chemical engineer in the fields of high-temperature heat transfer, radiation, and furnace design.

Distillation operations became continuous, not only by use of the continuous shell-still battery, but also by the combination of a pipe still and fractionating column. This was adopted not only to the production of gasoline, naphthas, kerosine, and the lighter distillates, but also to the production of vacuum-distilled lubricating oils, including cylinder stocks. The increasing demand for gasoline brought about similar developments in the cracking operation where the pipe still was found to be of particular importance because of the possibility of heating the oil to a much higher temperature than had ever been possible in the batch shell still. It also made possible the application of the principle of clean circulation in which only distillate products were cycled for a recracking through the pipe still. Large combination units of 60,000 barrels per day and more capacity were built with important saving in operating labor and the drudgery of maintenance. The percent of crude oil marketed as gasoline was increased from about 15 percent to over 45 percent with a saving of over 52 percent of crude oil requirements due to the development of efficient cracking operations.

Similar developments in the natural-gasoline field led to the recovery of over two billion gallons of natural gasoline per year (1930).

THE historical part of the paper by George Granger Brown before the National Chemical Conference in Chicago November 16, has been omitted because most of it is familiar to the personnel of the refining industry. In this he pointed out that chemical engineering as a profession had its start in 1888, although graduates from the new schools to offer the courses did not have much opportunity for influencing the operation of refining processes until World War I and "recognition of the necessity of anti-knock gasoline, particularly for the fighting planes and the demands on the chemical engineer for explosives, poison gas and the production of dyes, pharmaceuticals and other products for which we had previously relied upon Germany.

"Under the accelerates technical developments of the war period, the young chemical engineer learned to develop new and improved processes and equipment from his own resources whether or not they had been described to him in the accepted text books. He had also learned to apply the operations and skills acquired in one field to other fields of operations. When these men were demobilized and made available by the shifts in manufacturing activities immediately following the war, a relatively large number of young resourceful and progressive chemical engineers found themselves in the petroleum industry. The practical operator who had carried the petroleum processing from the days of the Civil War were being rapidly replaced by technically trained men."

Petroleum Research

The chemical engineer was making real contributions to the petroleum industry but it was by no means a one-way track. The technical developments in the petroleum industry were promptly described and made available to technical men in all fields. The development of chemical engineering since 1920 has been due in no small part to the technical and engineering developments in the petroleum industry. Furthermore, more than a half million dollars has been made available through the American Petroleum Institute for the encouragement of research connected with the problems encountered in the petroleum industry. The readiness with which the petroleum industry has made available technical data has greatly stimulated the interest of chemical engineers in the petroleum industry and for many years more than 10 percent of all the chemical engineering graduates in the country entered the petroleum industry.

Although petroleum played an important part in the World War of 1914-18, that war was made possible primarily by the development of synthetic nitrogen in Germany and the development of the coal-tar chemical industry at that time in Germany. Efforts were made at that time to produce toluene by the vapor-phase cracking of petroleum in California. Some toluene was produced, but of inadequate quality and quantity (not more than a single tank car altogether). Also at the end of World War I processes were developed for the production of an aviation fuel of 100-octane number, although not composed of iso-octane.

Our efforts in the present World War are based on an aviation fuel of 100-octane or more and by far the largest part of the satisfactory toluene used in the manufacture of explosives has been

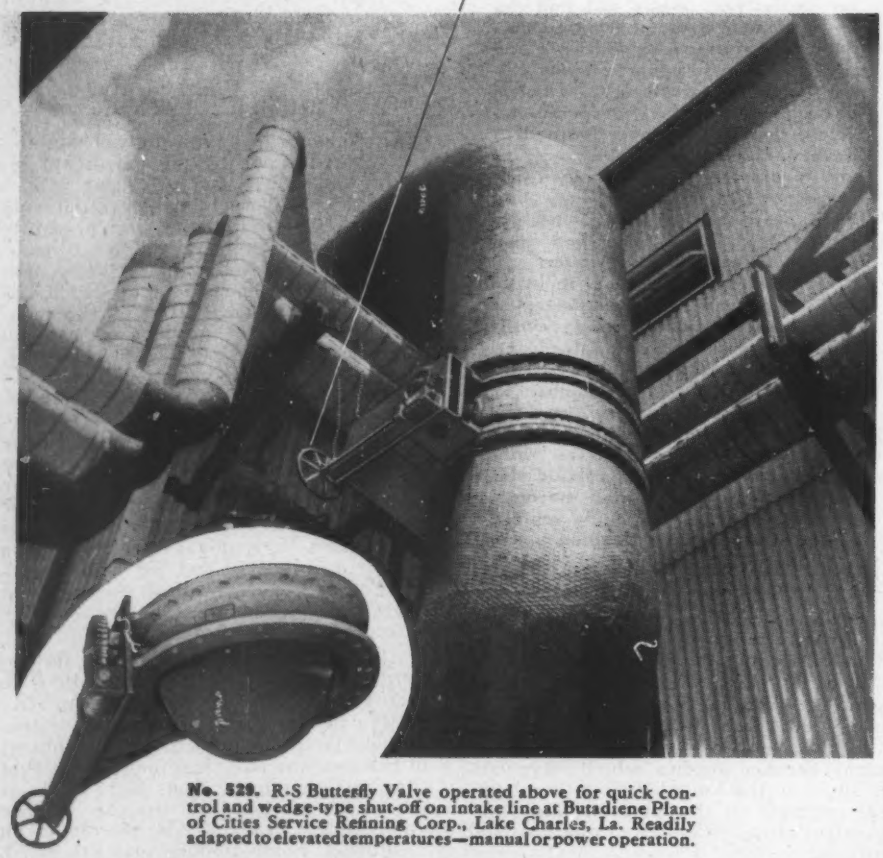
Quick Action
ON THE HOME FRONT!

Compared with the slow action of conventional type valves, it can be readily appreciated that R-S Butterfly Valves are easy and quick to operate. In the first place, no by-pass is required. Further, one thrust of the hand lever, or four to six revolutions of the hand wheel, complete the full vane movement. (Conventional type valves in the larger sizes require as long as five minutes or more for complete opening or closing.)

When open, there is minimum turbulence of the flow as the streamlined vane offers minimum resistance. In fact, the flow conditions are similar to those produced in a venturi tube with high pressure recovery on the down stream side.

Streamlined vanes, together with straight, accurately-machined body bores, make these valves self-cleaning. There are no troublesome pockets, seats or obstructions to retard flow, hence no accumulation of foreign material or stoppage is possible under normal conditions.

The comparatively lightweight and compact construction of R-S Butterfly Valves require less supporting structure and space, thereby effecting substantial savings in installation costs. Because of simplicity in design and standardized construction, they are lower in price yet comparable in efficiency to the highest type valve construction obtainable. Maintenance is practically nil. They can be depended upon to operate for years with trouble-free performance. Ask for Catalog No. 14-B.



No. 529. R-S Butterfly Valve operated above for quick control and wedge-type shut-off on intake line at Butadiene Plant of Cities Service Refining Corp., Lake Charles, La. Readily adapted to elevated temperatures—manual or power operation.

VALVE DIVISION

R-S PRODUCTS CORPORATION

120 Berkley Street • Philadelphia 44, Pa.

R-S Streamlined BUTTERFLY VALVES

produced from petroleum by catalytic processes developed by the chemical engineer. It seems true that we start the next war on the basis of the developments of the last war. Triptane and rocket bombs both supplied from petroleum as raw materials are where we shall probably begin next time. The contributions of the chemical engineer to the petroleum industry have had the effect of making this war truly a petroleum war and the petroleum industry a chemical industry even in the narrow sense of an industry whose major operations incorporate changes in chemical composition.

Primarily Process Engineering

Chemical engineering is primarily process engineering. The processes are actually operated and controlled by physical equipment and physical operations commonly referred to as the unit operations of chemical engineering. But we must remember that these unit operations are simply means to an end which is the industrial process itself. The knowledge of the process itself requires an understanding of the thermodynamic properties of the materials undergoing treatment, and the factors controlling the rates of the reaction or of the desired changes. It is only with a due consideration of all of these factors that a technically sound process can be evolved. In normal times the chemical engineer must also consider the economic factors if the process is to be a success. The petroleum industry is probably the best example of the practical application of chemical engineering on a grand scale.

With the possible exception of flotation, I believe, all of the unit operations of chemical engineering are used by the petroleum industry. Because of the large scale of the operations, intensive study for the improvement in efficiency is justified and a large part of the modern knowledge and understanding of the unit operations has been contributed by the petroleum industry.

The same statement may be made regarding the thermodynamic properties of hydrocarbons, particularly at high pressure. The mechanical engineer interested in power has always been concerned primarily with steam and possibly air as the two working substances. The chemical engineer deals with all kinds of gases and fluids and must have available reliable data or means for estimating the thermodynamic properties of whatever material is undergoing treatment. Furthermore, material with which the chemical engineer deals is usually not a single component such as water, but a complex fluid of many compounds. The natural-gas and petroleum industries have offered an ideal opportunity for the development of methods for estimating the thermodynamic properties of hydrocarbons and hydrocarbon mixtures. The chemical engineer has taken full advantage of this opportunity and has developed charts and tables by which the vapor-liquid compositions and the thermodynamic properties of the materials treated in the petroleum industry may be estimated in a rasonably satisfactory manner in most cases. These developments started with the simpler systems such as natural gas and natural gasoline composed almost entirely of paraffin hydrocarbons, were later extended to the higher-boiling, more complex mixture obtained from crude oil, and are currently being developed for the non-ideal mixtures in-

General Chemical "B&A" Reagent Acids and Ammonia

Quality in quantity shapes success... increases product potentialities. That's why, wherever *reagent grade mineral acids or ammonia in commercial quantities* are specified for industrial operations, General Chemical "B&A" high purity products are an outstanding choice nation-wide.

These reagents from America's foremost producer of mineral acids conform to exacting A.C.S. specifications. Their quality and purity are the result of General Chemical's progressive research and advanced reagent production technique, combined with invaluable "know-how" gained during almost half a century's manufacture of basic chemicals for industry.

Specify and rely on General Chemical "B&A" Reagent Acids and Ammonia for your operations. Remember... their dependability has been "proved in production" by America's leading manufacturers!

GENERAL CHEMICAL COMPANY

GENERAL CHEMICAL COMPANY
40 RECTOR STREET, NEW YORK 6, N. Y.

Technical Service Offices: Atlanta • Baltimore • Boston • Bridgeport (Conn.) • Buffalo • Charlotte (N. C.) • Chicago • Cleveland • Denver Detroit • Houston • Kansas City • Milwaukee • Minneapolis • New York Philadelphia • Pittsburgh • Providence (R. I.) • St. Louis • Utica (N.Y.)

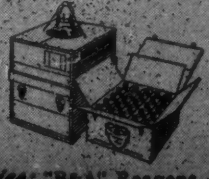
Pacific Coast Technical Service Offices:
Los Angeles • San Francisco • Seattle, Wenatchee and Yakima (Wash.)

In Canada: The Nichols Chemical Co., Ltd. • Montreal • Toronto • Vancouver

General Chemical Reagent Acids and Ammonia are produced by the Company's Baker & Adamson Division, makers of laboratory reagents and fine chemicals since 1882. The experience of this Division with high quality chemicals embraces over 1,000 purity products.

• • •

"B&A" Sulfuric Acid, Reagent, A.C.S.
Sp. Gr. 1.84
"B&A" Hydrochloric Acid, Reagent, A.C.S.
Sp. Gr. 1.18–1.19
"B&A" Nitric Acid, Reagent, A.C.S.
Sp. Gr. 1.42
"B&A" Ammonium Hydroxide, Reagent, A.C.S.
Sp. Gr. .90
"B&A" Acetic Acid Glacial, Reagent, A.C.S.



Quantities: "B&A" Reagent Acids and Ammonia are available in carboys as well as in five-pint or one-pound bottles, which are obtainable in case lots or less.

• • •

Stocked at key locations throughout the nation.

This is not a worker earning fabulous sums but an ordinary guy named "JOE"

. . . on the job every day, producing critically needed Thermometers so that GI Joe can do his job and return home soon.

To prevent costly breakdowns, after this war, it is your duty to give serious throught NOW to equipping your plant with GOOD Thermometers.

And Palmer Thermometers give you:

1. Precision and Guaranteed Accuracy.
2. Sturdiness and long life.
3. A bright RED column . . . so easy to see with "Red-Reading-Mercury."

CLIP THIS AD AS A REMINDER *(Catalog on Request)*

THE PALMER COMPANY

Makers of Industrial Recording and Laboratory Thermometers

2213 Norwood Ave. CINCINNATI 12 (Norwood), OHIO

Canadian Agent: The Scientific Supply Co., Toronto

cluding azeotropes as are used in extraction and extractive distillation operations.

Catalytic Reactions

Recently the petroleum industry has gone catalytic in a big way. We have catalytic cracking, catalytic hydrogenation, catalytic polymerization, catalytic alkylation, catalytic isomerization, just to mention a few. These reactions are rate-reactions and we expect to find shortly important contributions to the knowledge of the rate of catalytic reactions coming from the petroleum industry.

Perhaps one of the most interesting developments of these catalytic reactions is that the modern chemical engineer has demonstrated to the classical chemist that reactions involving the paraffin hydrocarbons such as alkylation and isomerization can and are being conducted on the large scale despite the firm opinion of classical chemists that such reactions were impossible.

I well remember a conference about 15 years ago at which engineers and organic chemists were present. The subject under discussion was the production of high anti-knock gasoline from Pennsylvania naphtha predominating in normal paraffins. The client had specified that he was not interested in any cracking operations but wished to develop some new method. The attention of the group was called to the fact that the isomeric paraffins were good anti-knock compounds and that it might be well to investigate the possibility of converting the normal paraffins into the isomeric paraffins by the use of some active catalyst such as aluminum chloride. The response was a hearty laugh with the comment that such reactions were utterly impossible. Now such reactions are being conducted on a large commercial scale and constitute a major factor in the supply of aviation motor fuel for the armed forces.

In these new processes which went into large-scale operations frequently before the opportunity of adequate pilot-plant investigation, the chemical engineer has not only been responsible for the existence of the process but also for its execution on a satisfactory and efficient basis. Although the efficiency or cost of an operation may not be as important as the technical aspects to the practical existence of a process in times of war, in normal peacetimes in this country we must recognize the all-important factor of cost. This is also true when contemplating what is popularly called reconversion.

The story of how American chemical industry has met the demand for synthetic rubber will be interestingly told by Dr. Semon in a few minutes. The plants are built, operating, and producing what appears to be a satisfactory product. It was and is recognized that petroleum offers the most economical source of butadiene for synthetic rubber GRS. But in the emergency alcohol could be converted to butadiene more readily than the plants could be built and operated to produce butadiene from petroleum and a large part of the butadiene has come so far from alcohol. But if this synthetic rubber is to continue as a major factor in the industry, it will be dependent upon the economical production of its raw materials from petroleum.

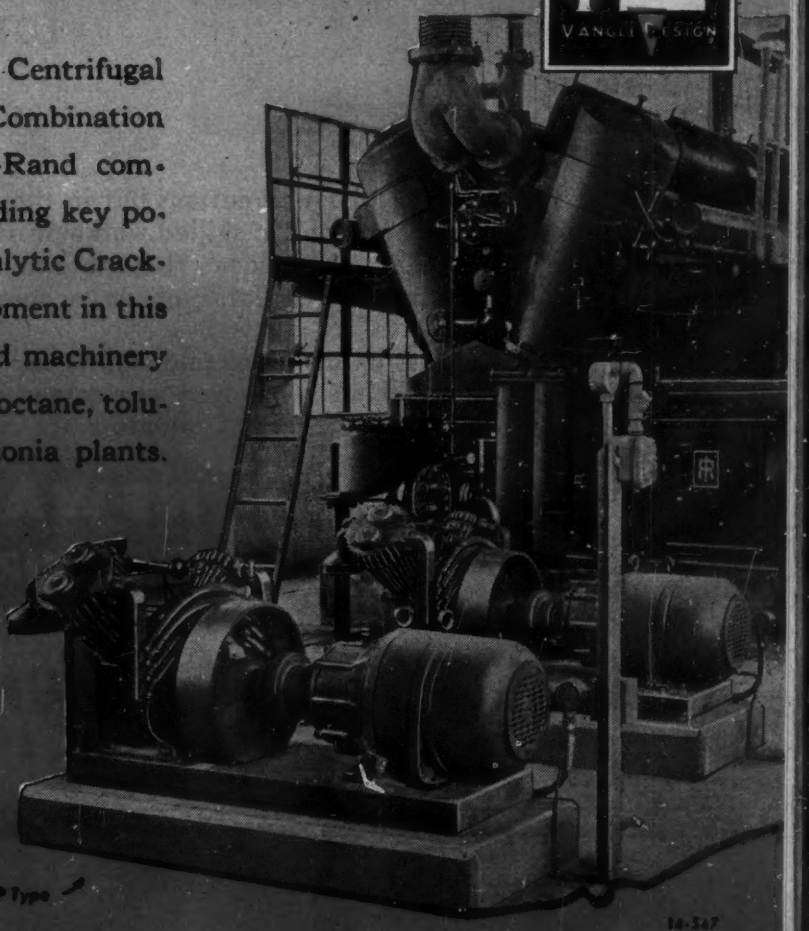
Chemical engineers also have played an important part in solving problems in gas and oil production, as these are

REFINERY

4-CYCLE

VANCE DESIGN

In 1937 Ingersoll-Rand supplied all the Centrifugal Pumps and Compressors for Richfield's Combination Cracking Units. Again in 1944 Ingersoll-Rand compressors, turbo-blowers and pumps are holding key positions in the new Richfield Thermofor Catalytic Cracking Plant at Watson, California. The equipment in this installation is typical of the Ingersoll-Rand machinery serving in most of this country's vital high-octane, toluene, synthetic rubber and synthetic ammonia plants.



Ingersoll-Rand

11 BROADWAY, NEW YORK 4, N. Y.

COMPRESSORS • TURBO-BLOWERS • ROCK DRILLS
AIR TOOLS • CENTRIFUGAL PUMPS • CONDENSERS
OIL AND GAS ENGINES

I-R Starting Units serve the seven 600 HP Type KVG Compressors.

14-547

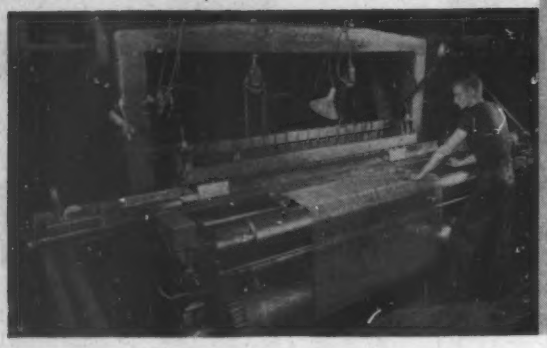
SKILLED WORKMEN

Making FINE CLOTH

★

Making MEDIUM MESH HEAVY CLOTH

★



Making HEAVIER CLOTHS

MACHINES are wonderful creations but in the making of wire cloth the hand of the skilled workman still sets up and controls the product of the loom. He's more than a watchman. At Newark, he's the creator of an accurately-made product.

We lay great stress on accuracy and rightly so, we believe. Of what use for screening is a woven wire screen if it is not accurate to begin with or cannot maintain its mesh count or spacing throughout its life.

The hundreds of NEWARK Wire Cloth users also believe that "accuracy in wire cloth" counts heavily.

NEWARK *for* ACCURACY

NEWARK WIRE CLOTH COMPANY

334 VERONA AVENUE, NEWARK 4, N. J.

12-NWC-4

primarily complicated problems in fluid flow requiring a knowledge and understanding of the thermodynamic properties of the fluids involved. The estimation of gas and oil reserves, the economical rates of oil production with proper regard for conservation, whether to cycle or not in the condensate fields, and problems of secondary recovery have all to be treated successfully by chemical engineers.

Perhaps a bit of philosophy is in order as to why the chemical engineer who is trained for process engineering in general rather than for the petroleum industry in particular has been so successful in that industry. The modern chemical engineer trained in the fundamentals of chemistry, physics, mathematics, unit operations, thermodynamics and process design as developed in and applied to industry in general, is unfamiliar with the particular lingo and peculiar methods of any particular industry; and, when placed in any particular industrial situation, he trys to reduce these unfamiliar peculiarities to their fundamental functions with which he is familiar. Thus the old batch still was analyzed in terms of its fundamental function, fractionation, and immediately associated with other equipment having the same function but much more highly developed elsewhere, and the chemical engineer introduced the bubble cap fractionation column into the petroleum industry as soon as he had the opportunity to study the processes and operations of the industry.

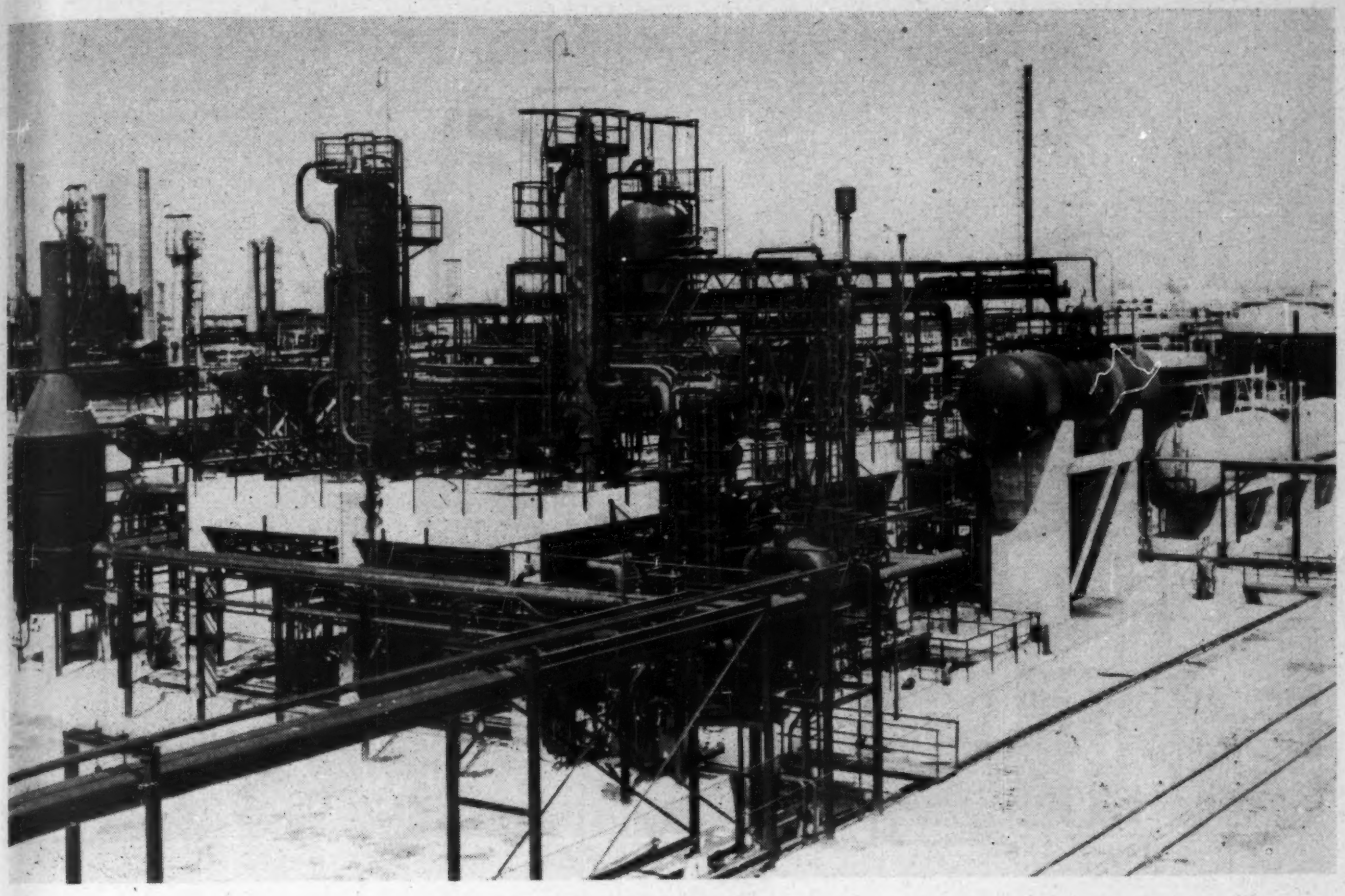
The man trained for a particular industry concentrates on the operations as conducted in that industry and becomes familiar with the peculiar language and methods used. If and when he enters the industry he is in a familiar field and accepts its practices as correct according to his training and background. In this state of mind he is never as likely to suggest improvements. He has been trained as a technologist in a particular field as to how that particular industry does its work—a specialist by exclusion of other fields—rather than in process engineering in general.

So long as chemical engineers are trained broadly in fundamentals as applied to process industries in general, they will continue to contribute to the advance of the petroleum industry by improving present processes and operations, developing new processes and products and decreasing costs. And, when and if, we must augment our supply of petroleum by liquid fuels produced from coal, shale or even "Jerusalem artichokes," the chemical engineer will be called upon to do the job.

Tax Receipts Show More Civilian Gasoline Use

Federal gasoline-tax collections in October of $38,374,828 were $6,000,000 above the previous month, and the highest for any month since November, 1940. For 10 months this year the total on federal gasoline taxes was $255,728,397 as compared to $217,152,865 during the same period last year. Lubricating oil assessments during the 10 months were $41,034,923, a gain over $40,612,446 in 1943. Pipe lines paid the government $13,547,047 in the 10 months, as against $11,725,810 for transportation tax last year.

Gulf's New Lubricants Plant, Port Arthur Refinery



Gulf Operating New 1000-Barrel Aviation Lubricants Plant At Port Arthur Refinery

GULF Oil Corporation has rounded out the expansion program at its Port Arthur refining plant with completion of facilities for making aircraft lubricants for military use.

The three-unit installation was put on stream in October and adds capacity for finishing an additional 1000 barrels of lubricating oils.

Completion of the lubricants plant followed completion of the processes by which Gulf Oil Corporation added to its output of 100-octane gasoline at Port Arthur. The Gulf plant, one of the larger refining installations in the United States, has added catalytic cracking, alkylation and polymerization units to its processing facilities and is one of the larger sources of high-octane aviation motor fuels.

This plant also provides part of the feed stock for the nearby butadiene plant of Neches Butane Products Company, largest of the plants in which butadiene is made from petroleum. Herbert Henderson, president of Gulf Refining Company, is chairman of the board of the community project for making this ingredient for GR-S rubber.

Three processes are combined in the new lubricant oil plant:

The deasphalting plant is shown on this page; both the phenol solvent extraction and the MEK dewaxing units are shown on a succeeding page.

For the present total output, around 1000 barrels per day, will be to the United States Army Air Corps and the Navy Bureau of Aeronautics. The first shipment was to the Army Air Corps October 24.

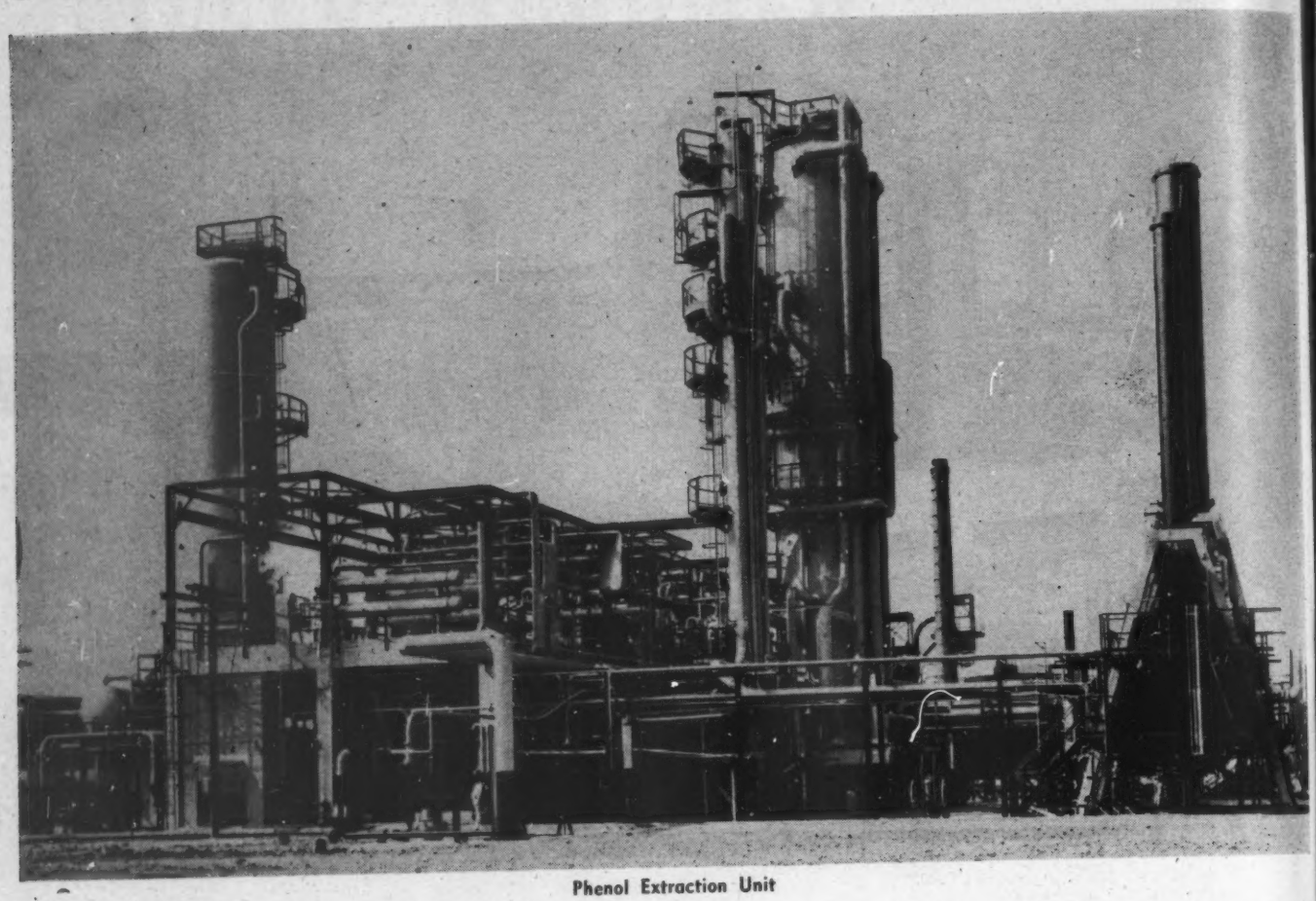
See additional plant pictures, page 160

The processes have been so designed that they can be operated to produce lubricants for civilian uses when the need for military lubricants has been reduced. Both automotive and industrial lubricants can be finished with slight changes in hook-up and in operating procedure.

The project was financed by private funds and completed under priorities of the War Production Board.

M. W. Kellogg Company was the contractor for the deasphalting and phenol units. The Lummus Company built the dewaxing unit.

Gulf's New Lubricants Plant, Port Arthur Refinery



Phenol Extraction Unit

MEK Dewaxing Unit

New Draft of Anglo-American Oil Pact Offered as Pending Agreement Seems Out

A revamped international oil agreement was proposed by the Petroleum Industry War Council at its meeting December 6. The council's action was in answer to the challenge of Petroleum Administrator Ickes that an acceptable draft be submitted, and came at a time when it had been made apparent by an announcement by Senator Tom Connally of the Senate Foreign Relations Committee that the pact which came out of the Anglo-American conference last August will not get committee approval. In effect the council's action throws the agreement back into the preliminary stage, which will require renewed negotiations with the British representatives who participated in framing the original proposal. Dissatisfaction with the original agreement had been expressed in both countries. The idea that such an agreement should be made, it was revealed in a speech by Ickes at Chicago on December 8, followed his misborn Arabian pipe line, which was a proposed encroachment upon British interests.

The new draft, prepared with the assistance of Judge Manley Hudson of the Permanent Court of International Justice, would offer no possibilities of application for any of the purposes which the industry saw inherent in the original version. It eliminates the provisions which had been denominated ambiguous, and incorporates limitations upon the authority of the commission and of the participating governments in any field bordering upon a cartel arrangement, protection for private competition and safeguards against interference with the domestic industry.

Oil Supply, Transportation Problem Still Not Licked

Continuation of the war in Europe through the first half of 1945 will find civilian supplies of oil in this country "barely adequate" to meet present rationed requirements, according to the December report of the Petroleum Industry War Council's economic committee. Gasoline will be particulary tight, and the situation will not be improved by the transportation shortage. For the first six months of 1945, the committee estimated need for 4,656,000 barrels of crude oil and 336,000 barrels of natural gasoline and other liquids daily, against an indicated average in 1944 of 4,582,000 barrels of crude oil and 287,000 barrels of natural gasoline, etc. Imports of crude oil increased the 1944 supply to an average of 5,000,000 barrels daily; for the first 1945 quarter total of domestic and imports will reach 5,153,000 barrels daily, and in the second quarter 5,191,000 barrels will be available for processing in American refineries. Imported crude will be made available in even larger quantity than indicated by these totals, as it is contemplated that some domestic wells now being produced above maximum efficient rates will be cut back as more oil is made available from outside. (Construction of some additional pipe lines in South America is scheduled for completion in January.)

However, it was stated, increase in demand will be in excess of the increase in supply. Demand in 1944 is estimated at 5,023,000 barrels, and is to increase to 5,466,000 barrels in the first quarter of 1945, then drop back to 5,180,000 barrels in the second quarter, for a six-months average of 5,325,000 barrels next year.

Recent developments in Europe have increased estimates of oil required there, and consequently has brought about a substantial increase in military tanker requirements. These increases again create a tight situation in this country, both as regards supply and transportation. Except for reasonably high stocks built up there recently, the situation would be particularly acute in the East. This situation is expected to continue during the first quarter of 1945, and easing then will depend upon the course of the war.

Gravity of the supply situation was emphasized in the report of John R. McWilliams, PAW director of production, who showed that current crude oil stocks of 223,000,000 barrels is dangerously near the 210,000,000-barrel minimum estimated as required working stocks for the refineries. These supplies, too, are unequally distributed.

Equipment prospects were pictured as less promising than for a month ago. Tubular goods and metal supplies in general are affected by the demands of the military for more shells and bombs, supplying which takes mill capacity and manpower which normally would make pipe for industry.

API Reelects Officers and Approves PIWC Oil Treaty

Officers and directors of the American Petroleum Institute were reelected at the annual meeting of the board at which the support of the association was thrown behind the revised oil treaty proposed by the PIWC.

The board devoted much of a brief session to a discussion of the treaty, and it passed a resolution which set forth the opinion of the board that the government should establish and maintain a consistent foreign oil policy:

"By giving necessary and legitimate diplomatic supply under the principles of international law, to its nationals engaged in foreign oil operations;

"By fostering the private enterprise of its nationals in foreign explorations, production, transportation, refining and marketing of petroleum and its products;

"By the establishing as a cardinal principle in such foreign oil policy of the government of the United States that the government itself will not directly or indirectly engage in foreign oil ownership, exploration development, or operation, either in its sovereign or proprietary capacity, or through the media of ownership in corporations or other agencies engaged in the petroleum industry; and

"By creating an international instrument of consultation and collaboration, without power of enforcement and in which there is joint government-industry representation, as essential to further

Crude Oil Run to Stills, Production of Refined Products, and Stocks for the Four-Week Period Ending November 25, 1944

(Figures, in thousands of barrels of 42 U. S. gallons each, based on reports of American Petroleum Institute. Production and stocks include reported totals plus estimated amounts to make these figures on a Bureau of Mines basis)

DISTRICT	Daily Refining Capacity		Crude Runs to Stills		Production				Stocks at Refineries, Terminals and in Pipe Lines				Crude Oil	
	Potential Rate	Percent Reporting	Daily Average	Percent Operating	Gasoline*	Kerosine	Gasoil and Dist. Fuel Oil	Residual Fuel Oil	Finish and Unfinished Gasoline	Kerosine	Gasoil and Dist. Fuel Oil	Residual Fuel Oil	Daily Average Production	Stocks
East Coast	729	100.0	694	92.6	6,859	574	3,175	6,254	11,995	6,101	14,040	10,351	.....	.....
Appalachian District 1	130	83.9	98	75.5	1,156	246	314	325	2,445	311	492	326	.....	.....
Appalachian District 2	47	87.2	50	105.9	643	28	158	327	1,570	78	218	145	.....	.....
Illinois, Indiana, Kentucky	824	85.2	778	94.4	11,325	1,034	2,535	4,285	16,028	2,533	7,181	3,763	.....	.....
Oklahoma, Kansas, Missouri	418	80.2	352	84.2	5,427	456	1,436	1,783	7,460	782	2,455	1,645	.....	.....
Inland Texas	278	66.9	230	82.7	3,660	347	458	1,704	2,843	275	428	601	.....	.....
Texas Gulf Coast	1,165	90.5	1,133	97.3	14,609	1,744	5,565	7,624	14,451	1,737	7,655	8,216	.....	.....
Louisiana Gulf Coast	242	95.5	265	109.4	3,083	938	1,283	1,381	4,132	855	2,180	1,202	.....	.....
North Louisiana-Arkansas	104	68.0	79	75.7	890	196	264	478	2,406	236	637	316	.....	.....
Rocky Mountain District 1	13	17.0	11	86.5	415	28	80	242	65	.....	19	31	.....	.....
Rocky Mountain District 2	141	58.3	100	71.1	1,191	46	248	687	1,655	108	387	589	.....	.....
California	817	89.9	825	100.9	8,486	171	2,465	10,727	14,371	486	11,409	35,650	.....	.....
Total U. S. November 25, 1944	4,908	87.2	4,615	94.0	57,744	5,808	17,981	35,817	79,421	13,502	47,101	62,835	4,730	221,431†
Total U. S. October 28, 1944	4,908	87.2	4,775	93.8	.....	.....	.....	.....	79,058	14,323	48,863	64,224	.....	223,235‡
Total U. S. November 27, 1943	.....	.....	4,282	.....	.....	.....	.....	.....	69,229	10,699	45,449	61,735	.....	239,869‡

*Includes natural gasoline blended at refineries. †Bureau of Mines, November 18, 1944. ‡Bureau of Mines.

world oil developments on a basis of mutual respect."

The August 8 agreement developed by the State Department, the resolution declared, is in conflict with those principles.

Officers reelected were: president, W. R. Boyd, Jr.; vice president of production, George A. Hill, Jr.; vice president of refining, J. Howard Pew; vice president of marketing, E. V. Weber; treasurer, O. D. Donnell; secretary and assistant treasurer, Lacey Walker.

Taber Elected President Sinclair Refining Company

George H. Taber, Jr., has been elected president of Sinclair Refining Company in an adjustment of executive personnel which advanced Sheldon Clark to chairman of the executive committee of Sinclair Oil Corporation, following the recent death of E. W. Sinclair. Albert E. Watts was named executive vice president and director, and Leland V. Stanford was elected a director. George R. Lord, refineries manager, was elected vice president of Sinclair Refining Company to succeed Taber, and John W. Duckett was appointed refineries manager.

Taber joined the Sinclair organization in 1919, and has been manager of the natural-gasoline department, vice president of Sinclair Oil & Gas Company, and president of Sinclair Crude Oil Purchasing Company. Since 1923 he has been vice president in charge of all refining operations. He received his B. S. degree in mechanical engineering from the University of Pennsylvania in 1911, and master's degree in chemical engineering from Massachusetts Institute of Technology in 1913.

Clark joined the organization in 1916 and for several years has been a vice president and director of the parent company and a vice president of Sinclair Refining Company, with headquarters at Chicago, where he is prominently identified with civic and philanthropical affairs. He is a member of the board of directors of Western Petroleum Refiners Association and of the National Petroleum Association. He is national president of the Navy League of the United States, vice chairman of the Joint Army and Navy Committee on Welfare and Recreation, and national commodore of Sea Scouts.

Watts was among the original officers of the first Sinclair company organized in 1916, and has been a director and member of the executive committee for a number of years. He has served as the head of the company's foreign operations, and for many years was president of Sinclair Navigation Company. He has been an active member of many of the principal functional committees in the East under Petroleum Administration for War.

Vagtborg to Head Research Institute at Kansas City

Harold Vagtborg, director of Armour Research Foundation, Illinois Institute of Technology, Chicago, on January 1 will become president of Midwest Research Institute, Kansas City, Missouri. The latter has been founded as a nonprofit research organization to develop agriculture, business, commerce, industry and natural resources of the Midwest.

Armour Research Foundation under Vagtborg's leadership has grown from a staff of three scientists with a budget of $300,000 to its present status of 300 persons, occupying five buildings, and with an annual budget of $1,500,000.

Vagtborg recently was elected to the board of trustees of Illinois Institute of Technology.

Bruce K. Brown Returns To Duty With Indiana

Bruce K. Brown has returned to his duties as director and general manager in charge of research and development of Standard Oil Company (Indiana) after service with PAW at Washington since 1941. Joining OPC in 1941, since early in 1942 he has been special assistant to the deputy administrator of PAW, in charge of the gasoline program.

Bullock Heads PAW Office at Chicago

Edward J. Bullock has been named director in charge of Petroleum Administration for War District 2 (Chicago) to replace W. W. Vandeveer who resigned to return to private business. Bullock, who retired in 1939 after 47 years with Standard Oil Company (Indiana) where he was a vice president and director, since 1942 has been PAW director of facilities security in District 2.

Effective December 1, the PAW office at Tulsa was further curtailed and operators directed to send all forms and applications in connection with materials and equipment to Chicago. Representatives of the natural-gas and natural-gasoline divisions and the facilities security division will remain at Tulsa, and L. B. Holland, director in charge of materials for the district will spend much of his time there.

Socony-Vacuum Names Two To Manufacturing Committee

Dr. J. B. Rather and W. M. Holaday have been named members of the manufacturing committee of Socony-Vacuum Oil Company. Rather becomes technical advisor to the committee, and Holaday succeeds Rather as manager of the general laboratories.

Rather graduated from Agricultural and Mechanical College of Texas and continued his studies at University of Chicago and Johns Hopkins. Before entering the oil industry in 1918, he was assistant state chemist of Texas, assistant chemist at Texas Experimental Station, and professor of agricultural chemistry and chemist of Experimental Station, University of Arkansas. In 1918 he became assistant and subsequently chief chemist of Standard Oil Company of New York. Since 1932 he has been general manager in charge of research, development and technical service laboratories for Socony-Vacuum Oil Company, and has served as chairman of the refinery processes committee. He is a vice president and director of Neches Butane Products Company. He is

SHELDON CLARK

GEORGE H. TABER, JR.

ALBERT E. WATTS

AHEAD WITH DRESSER

DRESSER INDUSTRIES now number ten.

Formerly, we were seven companies helping to bring basic services to the user more efficiently.

Our three new partners, each a specialist in its fields, both round out and broaden Dresser's scope of usefulness. This larger Dresser group can now serve industry and consumers with more products and greater experience.

The new Dresser members are bulwarked by an organization that assures their customers continued progress in product improvement, greater wherewithal for pioneering research and steady maintenance of service.

Dresser Industries, Inc., has progressed through the management principle of giving to alert, independent know-how an adequate backing and pooled resources. From these, each member draws teamed strength far greater than it could enjoy alone. The three new members of Dresser Industries, Inc., increase opportunities for mutual aid among the teammates, and at the same time, draw from the group advantages for those they serve.

MEMBER COMPANIES

Dresser Manufacturing Division
Bradford, Pa.

The Bryant Heater Co.
Cleveland, Ohio

Clark Bros. Co., Inc.
Olean, N. Y.

Pacific Pumps, Inc.
Huntington Park, Calif.

Bovaird & Seyfang Mfg. Co.
Bradford, Pa.

Dresser Mfg. Co., Ltd.
Toronto, Ont.

Van der Horst Corp. of America
Olean, N. Y. Cleveland, Ohio

PLUS

*International Derrick & Equipment Co.
Columbus and Marietta, Ohio
Torrance, Calif. Beaumont, Texas

*Roots-Connersville Blower Corp.
Connersville, Ind.

*Stacey Bros. Gas. Construction Co.
Cincinnati, Ohio

DRESSER Pipe couplings and repair devices for pipeline systems. Rings and forgings.

BRYANT Gas-fired boilers, winter air conditioners, furnaces, unit heaters and conversion burners for residential, commercial and industrial heating.

CLARK Engines and compressors for oil production and refining. Marine and stationary Diesel engines.

PACIFIC Hot-oil charging pumps; boiler-feed pumps; general-service pumps for the petroleum and other industries; oilwell plunger pumps; deep-well turbine pumps.

INTERNATIONAL DERRICK Oilwell pumping units, derricks and masts, drawworks, rotary tables and drilling units. Airport, communications and electric-power-line equipment and prefabricated steel buildings.

ROOTS-CONNERSVILLE Positive displacement and centrifugal blowers, exhausters, boosters and compressors. Air and liquid pumps and meters.

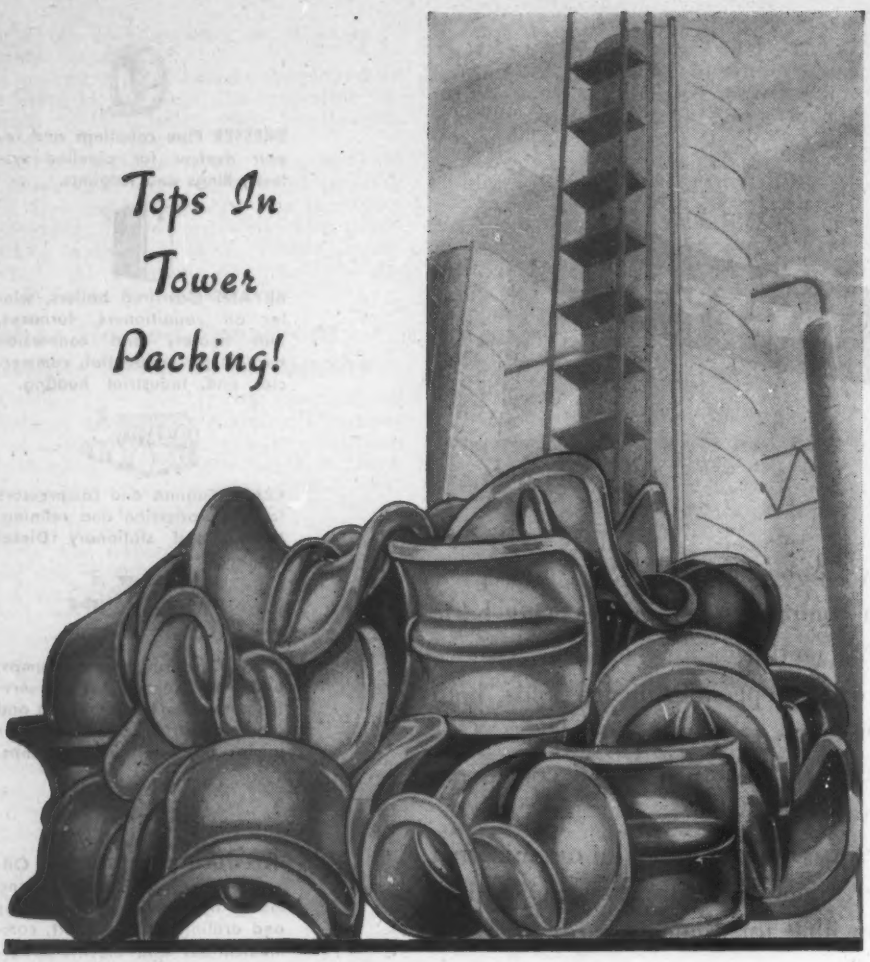
STACEY BROS. Storage holders, tanks and pressure vessels for the gas, oil, chemical and food industries.

BOVAIRD & SEYFANG Pumping engines, jacks, "powers", storage tanks and allied supplies and equipment for oilfields.

VAN DER HORST PORUS-KROME—a patented process of applying chromium lining on cylinder walls, piston rings and crankshafts—for longer wear.

DRESSER INDUSTRIES
INCORPORATED

Tops In Tower Packing!



BERL SADDLES

Provide—

Larger usable surface . . . from 20% to 60% more usable surface per unit volume than rings of similar size.

Less resistance to flow . . . as much as 50% less resistance saves power.

Better distribution . . . nearly 100% greater average angle of distribution within the packing.

Higher loading capacity . . . can handle more vapors and liquids simultaneously without flooding. This provides greater capacity for your liquid-vapor reaction towers.

Berl Saddles are available in acid-proof chemical stoneware, white porcelain or special porous ceramics. Prompt delivery on ½", 1" and 1½" sizes.

MAURICE A. KNIGHT

812 Kelly Ave., Akron 9, Ohio

KNIGHT-WARE
CHEMICAL EQUIPMENT

author or joint author of 35 articles on organic, analytic, plant and animal chemistries in various scientific publications.

Holaday received his degree in mechanical engineering from Ohio State University in 1925 and shortly thereafter joined the research staff of Standard Oil Company (Indiana), where he remained until 1937 as automotive research engineer. In that year he became manager of the research, development and technical service divisions of Socony-Vacuum Oil Company's general laboratories. In 1943, on leave, he served Petroleum Administration for War, first as chief of the aviation section and later as assistant director of refining, returning to the company in September, 1944.

Bay Petroleum Corporation Buys New Orleans Plant

Bay Petroleum Corporation has purchased Chalmette Petroleum Corporation, New Orleans, for a consideration in excess of $1,000,000. Properties include a 9000-barrel refinery, barge terminal and tank farm on the Mississippi. C. U. Bay has become chairman of the purchased company in its new corporate setup, other officers including R. V. Rodman, president, C. O. Garbrecht, vice president, D. H. Hand, secretary-treasurer, and L. A. Vivien, general manager.

McKeever Named to Head Pan American Petroleum

E. G. McKeever, executive vice president of Pan American Petroleum & Transport Company, has been elected president of the company to succeed Robert E. Wilson who becomes chairman of the board of Standard Oil Company (Indiana) on January 1. McKeever also becomes president or vice chairman of the subsidiary companies.

D. J. Smith, who for 12 years has been vice president of Pan American Refining Corporation, will become president of that company, operating refineries at Texas City, Texas, and Baltimore, Maryland; Pan American Production Company, Pan American Pipe Line

D. J. SMITH

TIDE, AUGUST 1, 1944 — 35

the Weather eats out of his hand

▶ Mark Twain to the contrary, somebody *does* do something about the weather—makes it, in fact, just as he wants it—is able to forecast it months in advance.

His is the job of keeping 4,200,000 cubic feet at NBC temperature ideal, dew point just what it should be, humidity never varying.

Humidity, that's the important thing in manufacturing made-to-order weather and processing it for string and percussion instruments, singers' throats and a host of performers who need the best atmospheric conditions for the best performances.

That's why NBC operates one of the most completely integrated air-conditioning systems in the world . . . 64 separate mechanical lungs so delicately coordinated that hundreds of people may enter one studio without raising or lowering the temperature in the one next door.

This elaborate air-conditioning system helps keep actors and audiences comfortable and responsive, of course, but all that is secondary to the role it plays in contributing to better broadcasting . . . building a smoothness of presentation, a fidelity of instruments and vocal cords which contributes so much to the perfection of NBC's musical presentations.

* * *

Custom-built weather is just one of the many examples of the manner in which NBC strives for perfection in the little things of radio, knowing that the grand total of little things well done helps NBC maintain its leadership, helps make NBC *"The Network Most People Listen to Most."*

They all tune to the

National Broadcasting Company

It's a National Habit

America's No. 1 Network — NBC — A Service of Radio Corporation of America

BUY MORE WAR BONDS AND KEEP 'EM!

ARMY E NAVY

If you need instrumentation for any process, we believe it will pay you to call Taylor first. Chances are 99 to 1 we can help you because Taylor Fulscope Controllers are equally adaptable to temperature, pressure, rate of flow, or liquid level. And they're available in five completely interchangeable forms of control to meet practically any processing requirements or operating conditions. Taylor Instrument Companies, Rochester, N. Y., and Toronto, Canada.

Taylor Instruments

MEAN

ACCURACY FIRST

IN HOME AND INDUSTRY

The Starting Point

In the engineering departments and shops of Associated many hundreds of piping jobs, small as well as large, have had their beginning. All were completed and placed in economical operation—under supervision of Associated's field engineers, if required.

But our interpretation of "the starting point" goes a bit deeper. We consider that a good start, with every minute detail acknowledged and classified, is best assurance, or best insurance, of a successful finish. And we assume this responsibility in every instance.

Finally, and most important, we consider that our original job with each new firm is the starting point, the beginning of a long and pleasant period of friendship—the beginning of increased economies in your industrial piping requirements. We make it that way.

ASSOCIATED PIPING & ENGINEERING CO., Inc.
2332 East 38th Street • Los Angeles 11, California

ASSOCIATED Progressive PIPING

P. J. SWEENY

Company and Pan American Gas Company, operating in Texas and Louisiana, and Mexican Petroleum Corporation of Georgia which operates a refinery at Savannah, Georgia. He will continue his headquarters in New York. Joining the company in 1927, Smith directed construction of the refinery at Aruba, and later at Texas City.

P. J. Sweeny, who has been manager of the refinery at Texas City, has been made a vice president of Pan American Refining Corporation.

Safety Council Announces Officers of Petroleum Section

National Safety Council, following its recent session at Chicago, has announced the following of the Petroleum Section executive committee:

General Chairman, John C. Askam, The Ohio Oil Company, Findlay, Ohio.

Vice Chairman for Production, D. A. Klemme, Stanolind Oil & Gas Company, Tulsa.

Vice Chairman for Marketing, George A. Lexander, Socony-Vacuum Oil Company, East Boston, Massachusetts.

Vice Chairman for Pipe Lines, W. I. Kent, Magnolia Petroleum Company, Dallas.

Vice Chairman for Manufacturing, A. J. Gorand, Sun Oil Company, Philadelphia.

Secretary, D. V. Stroop, American Petroleum Institute, New York.

News Letter Editor, W. K. Bergen, Standard Oil Company (Ohio), Toledo.

Associate Editor, C. R. Sliger, Insurors Indemnity & Insurance Company, Tulsa.

Contest and Statistics Committee Chairman, J. Willard Lord, The Atlantic Refining Company, Philadelphia.

Engineering Committee Chairman, L. F. Knox, General Petroleum Corporation, Los Angeles.

Health Committee Chairman, Dr. R. W. Pipkin, Humble Oil & Refining Company, Baytown, Texas.

Industrial Data Sheet Committee Chairman, W. A. Allred, Lone Star Gas System, Dallas.

Off-The-Job Safety Committee Chair-

INSULATION helps speed penicillin production

Armstrong's Corkboard and Cork Covering help maintain exact temperatures in mass production of this wonder drug

At several stages in the production of penicillin, unvarying temperatures must be maintained to prevent contamination. In processing this life-saving drug, precise low temperatures must be held to keep the protein content "fixed," and thus retain its potency. Certain vats and rooms are refrigerated, and the air in them is sterilized. In these air-conditioned and refrigerated areas, insulation plays a vital part in holding the correct temperatures regardless of outside conditions.

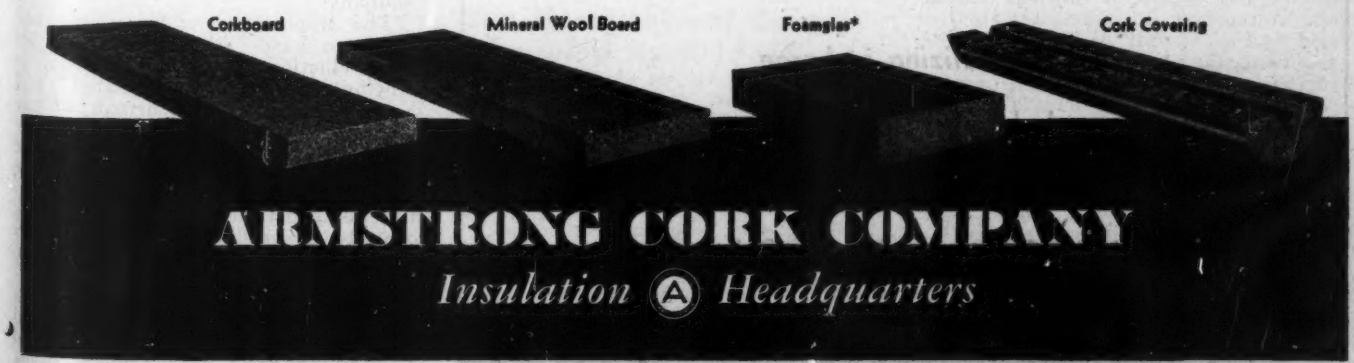
In selecting insulation for these areas and refrigerating equipment, absolute dependability was a prime requirement. That is why Armstrong, with its 40 years' experience in the manufacture and application of low-temperature insulation, was called upon to insulate several penicillin plants. Armstrong's Corkboard and Cork Covering have already helped to produce billions of units of this wonder drug.

New problems of low-temperature control come to Armstrong engineers year after year. Each problem is solved in a practical way because they have handled a variety of low-temperature insulation jobs, both simple and complex, in many fields.

In three important ways, Armstrong's "know-how" follows through to assure dependable insulation. Armstrong offers first, a complete line of efficient materials including Corkboard, Mineral Wool Board, Foamglas*, Cork Covering, and sundries for their efficient erection; second, practical engineering aid in planning and designing the insulated structure; and third, proper installation—for all Armstrong offices and distributors maintain crews of skilled mechanics.

For complete information, write today to Armstrong Cork Company, Building Materials Division, 7512 Concord Street, Lancaster, Penna.

* Reg. U. S. Pat. Off. Product Mfg. by Pittsburgh Corning Corp.



ARMSTRONG CORK COMPANY

Insulation Headquarters

RECORD
OF ACHIEVEMENT

Since its organization in 1918 and its incorporation in 1925, the firm of Fischbach & Moore has grown steadily until today it occupies the leading position in the nation in electrical construction field.

To date it has completed over 8,600 projects including some of the largest in the country.

With a complete organization strategically located, Fischbach & Moore is fully equipped and prepared to "do the job from Coast to Coast."

Fischbach & Moore

OF TEXAS, INC.

ELECTRICAL ENGINEERS
AND CONTRACTORS

Specializing in Large
Industrial Installations

HOUSTON ★ DALLAS

man, Roy S. Bonsib, Standard Oil Company, New York.

The vice chairmen constitute the program committee.

Visual Education Committee Chairman, Frank Harrison, Pure Oil Company, Chicago.

Atlantic Division Chairman, P. J. Jolly, The Texas Company, New York.

Great Lakes Division Chairman, Jos. C. Bernd, Sinclair Refining Company, East Chicago, Indiana.

Gulf Coast Division Chairman, Crymes Pittman, United Gas Pipe Line Company, Shreveport.

Mergers Provided as PAW Set-up Is Revamped

Revamping of the PAW set-up, splitting the construction division into two groups to be merged, respectively, with the refining and materials division, was announced December 6. No reduction in personnel is involved.

George Gibson, director of the construction division, becomes construction officer and continues as vice chairman of the facilities review committee. He will serve all domestic and foreign operating divisions and will be directly responsible for the completion of 100-octane construction and other domestic refining construction programs.

M. B. Fitzgerald, formerly assistant director, will be in charge of the new construction section of the refining division, and Leo Connell will go to the materials division as assistant director in charge of a new equipment-scheduling and special-ratings section.

The five district construction committees will be liquidated and their functions assigned to the refining and materials committees. Most of the PAW-sponsored construction program is completed, but the work is not yet done; in fact, with the stepped-up air offensive, the 100-octane program has entered an especially critical stage. The task now is to determine the refiners' needs and to obtain prompt delivery of equipment, improve the quality of the gasoline, and increase the output of components such as tetraethyl lead, it was said.

Texaco, Cyanamid Organize Petroleum Chemical Unit

Jefferson Chemical Company, to engage in manufacture and sale of chemicals from petroleum, has been organized under joint ownership of The Texas Company and American Cyanamid Company. Headquarters will be at 30 Rockefeller Plaza, New York, and manufacturing plants will be adjacent to larger refining plants of The Texas Company.

"The importance of petroleum and petroleum gases as raw materials for the production of chemical substances is being increasingly appreciated," said W. S. S. Rodgers, chairman of the board of The Texas Company, in a statement announcing formation of the company. "Great strides have been made in this field during the war. Many constituents of petroleum gases which were formerly by-products of oil refineries now are in demand as raw materials. We have, therefore, established Jefferson Chemical Company to explore this field and produce from petroleum and petroleum gases such chemicals and chemical products as are likely to

in demand by various consuming industries."

Directors of the new company are Rodgers, W. B. Bell, Harry T. Klein, H. L. Derby, M. Halpern, K. F. Cooper, R. J. Dearborn, M. C. Whitaker, W. M. Stratford, R. C. Gaugler, W. E. Kuhn, and L. C. Perkinson. Officers are Bell, chairman of the board; Rodgers, vice chairman; Derby, president; P. M. Dinkins, vice president and general manager; Dearborn and Halpern, vice presidents; K. C. Towe, treasurer; W. P. Sturtevant, secretary; W. G. Elicker, assistant secretary and assistant treasurer.

Sun Completes War Plant Construction Program

Completion of a two-unit Thermofor Catalytic Cracking plant at its Marcus Hook, Pennsylvania, refinery concludes a construction-for-war program by Sun Oil Company which brings to $29,500,000 the amount so expended by the company for such purpose. The two units which recently went on stream have combined charging capacity of 20,000 barrels per day, and are integrated with other units of the refinery to increase production of gasoline for aviation combat use. Construction was done largely by the company's own construction department with the assistance of E. B. Badger & Sons Company. All of this company added facilities have been privately financed.

Shell Gets Authority to Expand Houston Plant

Shell Oil Company has been given approval for enlargement of its Houston refining plant. War Production authorization came early in December on projects which will involve expenditure of $11,000,000.

A fluid-catalytic cracking unit, a gas-concentration section, an alkylation unit, as well as additions to the boiler plant and electric generating units are among the major items of construction. The new facilities will give the plant processes for finishing 100 octane-aviation motor fuel.

Contracts have been let with C. F. Braun Company, Alhambra; The Fluor Corporation, Los Angeles, and Foster Wheeler Corporation, New York, for construction of these facilities.

Hugoton Black Plant Will Operate During Emergency

Cabot Carbon Company will construct and operate for account of Defense Plants Corporation, a channel-process carbon-black plant to consume 30 million feet of gas daily from the Hugoton, Oklahoma, field. The plant is to cost $1,500,000, and is to be operated only during the war emergency and for six months thereafter. Permit to process the gas for black was obtained from Oklahoma Corporation Commission through pressure from War Production Board. Oklahoma heretofore has consistently refused authority for black plants where any other market was available for sweet gas, and limitation of the term of the permit is a continuation of that policy after the urgent war need for black has passed.

Furfural Supply Easier

Furfural has been removed from the critical list of war materials as availability has improved materially. Still under War Production Board control, it has been moved from Group I to Group II, indicating supply sufficient for current military and essential industry needs.

Creole Ready to Build Refinery in Venezuela

Creole Petroleum Corporation is about ready to proceed with construction of a 40,000-barrel refinery in Venezuela, a company spokesman in that country has revealed to a Dutch news agency. Location of the plant has not been announced other than it will be in the central part of the country. The refinery is being built in line with an agreement between the company and the government, made in 1943, under which the plant is to be a complete unit. The company is completing a pipe line in Venezuela to move 90,000 to 100,000 barrels per day. It has daily crude oil production in Venezuela of 387,000 barrels, or about half of the country's total output.

White Horse Refinery May Go to Interior Department

Negotiations in Washington between Army and Department of the Interior officials indicate that operations of the Canol project in Canada may be turned over to the latter. Because of the change in the war picture, it was indicated the Army wishes to turn over operation of the White Horse refinery to some other organization.

Special Safety Award Goes To Colonial Beacon

Because of its outstanding record of 1008 consecutive days of operation without a single lost-time accident, Colonial Beacon Oil Company, Everett, Massachusetts, gained a special award November 31. A special vote of the board of governors of the National Safety Council created the award:

"For Distinguished Service to the Cause of Safety."

Carroll J. Mealy, division director of the council, made the award to Paul C. Shea, vice president and general manager of manufacturing of Colonial Beacon Oil Company.

The unusual record was ascribed in part of the system of frequent rotation of the employe membership of its safety committees, so that over a period of years a large percentage of the employes themselves have qualified as safety inspectors. The system is now being adopted by other refineries affiliated with Standard Oil Company (New Jersey).

(The system was the basis of an article by Paul C. Shea in the July 1944 PETROLEUM REFINER).

Gas Measurement Course Scheduled April 17-19

April 17-19 are tentative dates for the Southwestern Gas Measurement Short Course at the University of Oklahoma, Norman.

Earl Knightlinger, Arkansas Louisiana Gas Company, is chairman of the general committee.

Committee chairmen include: C. A. Gibson, Cities Service Gas Company, Bartlesville, Oklahoma, program; R. M. Schofield, Lone Star Gas Company, Dallas, exhibits; Miss Kate A. Niblack, Oklahoma Utilities Association, Oklahoma City, registration and publicity; Dean W. H. Carson, College of Engineering, University of Oklahoma, banquet, entertainment and local arrangements; W. H. Woods, Gulf Oil Corporation, Houston, study of practical methods.

William D. Yale, The Texas Company, Houston, was named to the general committee, replacing Max K. Watson, Canadian River Gas Company, Amarillo, who will become a member of the executive committee.

Material Supply Situation Eased

Greater freedom to use materials in certain operations was granted by PAW through amendment November 17 of orders to permit a maximum of $25,000 of materials which may be used without specific authorization. This material may be used for construction in refineries, transportation systems, pressure maintenance, gas cycling and gasoline plants. Heretofore the maximum was $10,000.

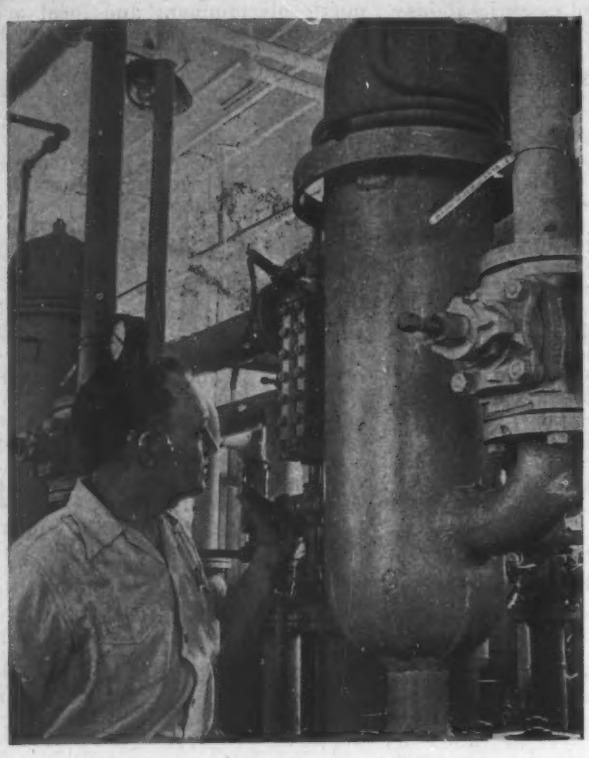
At the same time, requirements that operators report surplus stocks of materials was dropped, except in the case of tubular goods used in well drilling. Supply of steel has improved recently, but demand for pipe continues to exceed supply. Because of the contemplated stepping up of the drilling program, PAW deems it necessary to continue its strict control over the tubular goods supply.

PAW Says Industry Must Keep War-Age Technicians

PAW has warned against a shortage of aviation fuel within the next six months unless the oil industry's supply of technical talent is left undisturbed by military service demands. This warning followed a survey of data from its various departments and from the Department of Labor. Every technical man of draft age now employed in the industry must continue to be exempted from military service, it was held.

Difficulties confront the refining industry in the changes in the quality of aviation gasoline which are planned, the report stated, decrying the publicity to the effect that aviation gasoline is being produced in quantity equal to requirements. "This publicity can be dangerous to the plans of the military if the full meaning of the achievement of the industry is not brought to the attention of the proper governmental bodies," the report warned, pointing out that proposed quality changes will work a reduction in quantity.

The report concerned itself most with production problems, pointing out that current heavy demands upon the fields will continue through 1945, regardless of the war's progress, and that this production can only be maintained through further expansion of exploration and drilling. Work in the fields has been carried on largely with untrained personnel in the non-technical positions, and this branch was particularly a heavy loser of technically trained men because so many of them held reserve commissions in the Army and were otherwise desirable for that service because of their training. In the face of this obstacle, this branch of the industry has been able to increase production 25 percent. After reducing its operations 40 percent during the first two years of war and depleting personnel proportionally, workers for again increasing operations, now that the material situation has



JERGUSON

"ON THE SPOT" READINGS

To the operator, the JERGUSON Liquid-Level Gage shows the height of a tank's contents, entirely independent of recording or indicating meter readings located elsewhere. He should have that "on the spot" reading.

Should there be a stoppage of flow because of power failure, valve sticking, leaks, or other reason, the JERGUSON Gage will show the change in level instantly and *without fail*. This sure signal may well mean safety to personnel, equipment and product.

There are no working parts to the JERGUSON Gage. The level in the vessel is the level in the gage—it's just as simple and certain as that.

JERGUSON Gages are not affected by temperature, pressure, or corrosion. In JERGUSON, you have gages that work—always.

JERGUSON GAGE & VALVE CO.

87 Fellsway **Somerville 45, Mass.**

eased, have been obtained by industry-wide recruiting programs. But the limited number of these recruits and their inexperience are contributing to the current 30-percent inefficiency in drilling operations. Production in needed volume has been maintained at the expense of reserves, and the industry now faces the need of drilling more wells and finding more fields. Contemplated expansion of exploratory drilling to at least 5000 wells in 1945 as compared to less than 4000 in 1944, calls for a comparable increase in geological and geophysical activity. More than 50 percent of the personnel of geological and geophysical crews must be technically trained, and the industry already has given up 40 percent of its technicians in these activities to the armed forces.

Hydrogenation Patent Pool Dissolution Authorized

A supplemental order in the Standard Oil Company (New Jersey) case, authorizing the defendants to enter into a termination agreement and hydrogenation license agreements as contemplated in the consent decree of March 25, 1942, was filed in the United States District Court at Newark, New Jersey, by the Department of Justice December 4.

The order, entered upon the motion of the defendants with the consent of the department, provides for agreements which will establish a new basis for licensing hydrogenation patents pooled by Standard Oil Company (New Jersey) and 17 other companies—The Atlantic Refining Company, Bareco Oil Company, Cities Service Company, Continental Oil Company, Gulf Oil Corporation, Mid-Continent Petroleum Corporation, The Pure Oil Company, Richfield Oil Corporation, Shell Union Oil Corporation, Sinclair Refining Company, Skelly Oil Company, Socony-Vacuum Oil Company, Inc., Standard Oil Company (Indiana), Standard Oil Company of California, Standard Oil Company (Ohio), Standard Oil Development Company, The Texas Company and Union Oil Company of California.

Hydro Patents Company is a mutual corporation owned by 18 United States oil companies. It was formed in 1930 to facilitate the use by the oil industry of the hydrogenation process purchased by Standard Oil Company (New Jersey) in 1929 from I. G. Farbenindustrie. The process produces high yields of gasoline and light petroleum products from crude oil and can be used to produce oil from coal.

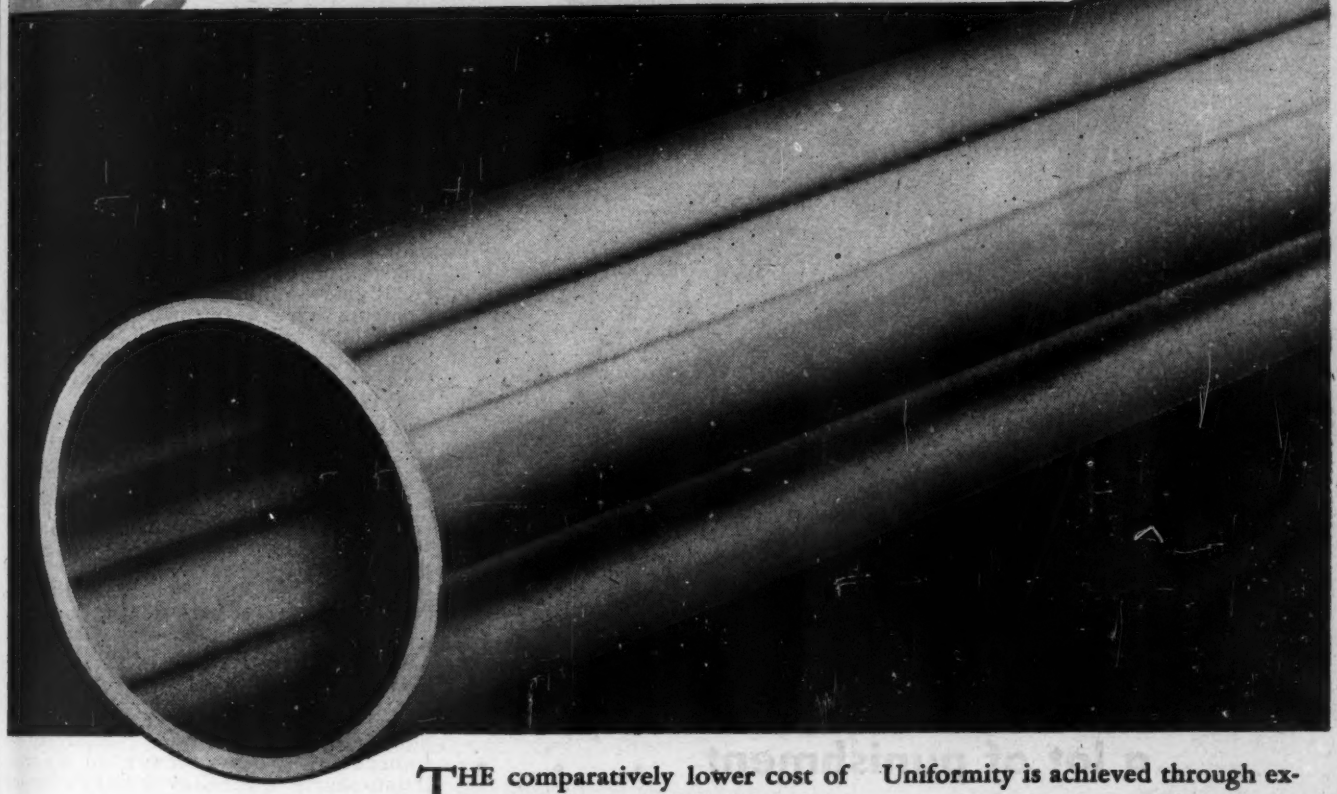
The function of Hydro Patents Company was to lincense hydrogenation patents, and the 18 companies participating in ownership held stock in proportion to the hydrogenation capacity for which they had taken licenses. Provision was also made for licensing the process to non-stockholders, though no applications were ever received.

At the time of the formation of Hydro Patents Company, hydrogenation was regarded as basic to the petroleum industry because the process could produce more than twice as much gasoline from crude oil as existing processes, and its use would extend the oil reserves of the United States which were then thought to be dwindling. However, subsequent discovery of large additional supplies of crude oil, particularly in East Texas minimized the essentiality of the hydrogenation process in this field for an indefinite period and

GLOWELD

. . . Globe ELECTRIC Welded Stainless Steel Tubing . . .

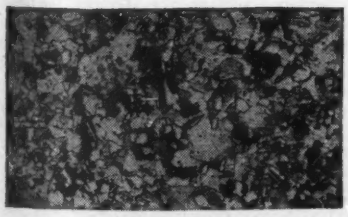
BROADENS THE USES OF STAINLESS



THE comparatively lower cost of GLOWELD Stainless Steel Tubing and the wide range of diameter and wall thicknesses, suggest many new applications for stainless tubing. Accuracy to size and gauge permits faster fabrication, easier bending, cutting, welding, expanding and flanging. There is no detectable flash at the weld because GLOWELD is produced by a closely controlled process.

Uniformity is achieved through exacting control in production processes and by thorough inspection at every step in manufacture.

Where lower cost is a factor and high-grade stainless steel tubes are required, GLOWELD offers an economical and satisfactory solution to the problem . . . perhaps to a problem of yours.



Photomicrograph of weld zone, showing grain structure of weld and parent metal.

★ STAINLESS TUBES
★ BOILER TUBES
★ GLOBEIRON TUBING
★ GLOWELD TUBES

GLOBE TUBES

★ CONDENSER AND HEAT EXCHANGER TUBES
★ MECHANICAL TUBING

GLOBE STEEL *Tubes*

GLOBE STEEL TUBES CO., *Milwaukee, Wisconsin, U.S.A.*

★ The makings of a BEAUTIFUL FRIENDSHIP

★ This bond with metal survives a lot of punishment . . .

Even *rust* can't come between metal and B-H No. 1 Cement! A special rust-inhibitor prevents corrosion and assures a permanent bond—whether the cement is applied on a hot surface and dried instantly or slowly air-dried over a period of time.

No. 1 Cement is made—by an exclusive process—of high-temperature-resisting, nodulated B-H *black* rockwool and other ingredients. Because it does not form a homogeneous mass, the *black* rockwool retains its physical characteristics; the countless *dead-air cells* provide full insulating efficiency up to 1800° F.

The cement retains sufficient elasticity to absorb normal expansion and contraction, without peeling or cracking. Easily applied without skilled labor; 100% reclaimable up to 1200°.

Please write for a practical sample and complete data.

For *one-block* insulation—at all temperatures up to 1700° F.—write for illustrated data on MONO-BLOCK.

Address: **Baldwin-Hill Co., 567 Klagg Ave., Trenton 2, N. J. Plants in Trenton, N. J.; Kalamazoo, Mich.; Huntington, Ind.**

Baldwin-Hill

COMPANY

HEAT & COLD INSULATIONS

only a few of the stockholders of Hydro Patents built the expensive plants required to utilize the process in this manner. For this reason, Hydro Patents took steps toward dissolution in 1940, and Standard Oil Company (New Jersey) confirmed, in the consent decree signed in 1942 with the Department of Justice, its intention to pursue the dissolution of this company.

The order signed by the court on December 4 authorizes New Jersey Standard to enter into an agreement for the dissolution of Hydro Patents and to grant hydrogenation licenses to the various companies formerly holding such licenses from Hydro Patents.

While hydrogenation was not widely utilized in the manner originally anticipated, it has been a vital process in the subsequent development of 100-octane gasoline. The first substantial quantities of synthetic aviation gasoline base stock for 100-octane were made in a large hydrogenation plant operated by Standard Oil Company of Louisiana at Baton Rouge. The process is now used for manufacture of a vital blending agent for 100 octane.

Rights to all of the hydrogenation patents have been made available by Standard Oil Company (New Jersey) without charge for the duration of the war under terms of the Consent Decree of 1942.

The termination and license agreements have been unanimously approved by the 18 companies which are stockholders of Hydro Patents Company, but which, except for Standard Oil Development Company, are not parties in the Standard Oil Company (New Jersey) case, it was said.

The agreements will lead to the dissolution of Hydro Patents Company, provided for in the consent decree, and assumption by Standard Oil Development Company and Standard Catalytic Company of its functions as licensor of the hydrogenation patents. The order provides that the agreements are to be concluded by next March 1 but the wartime saving of royalties is to be afforded retroactively.

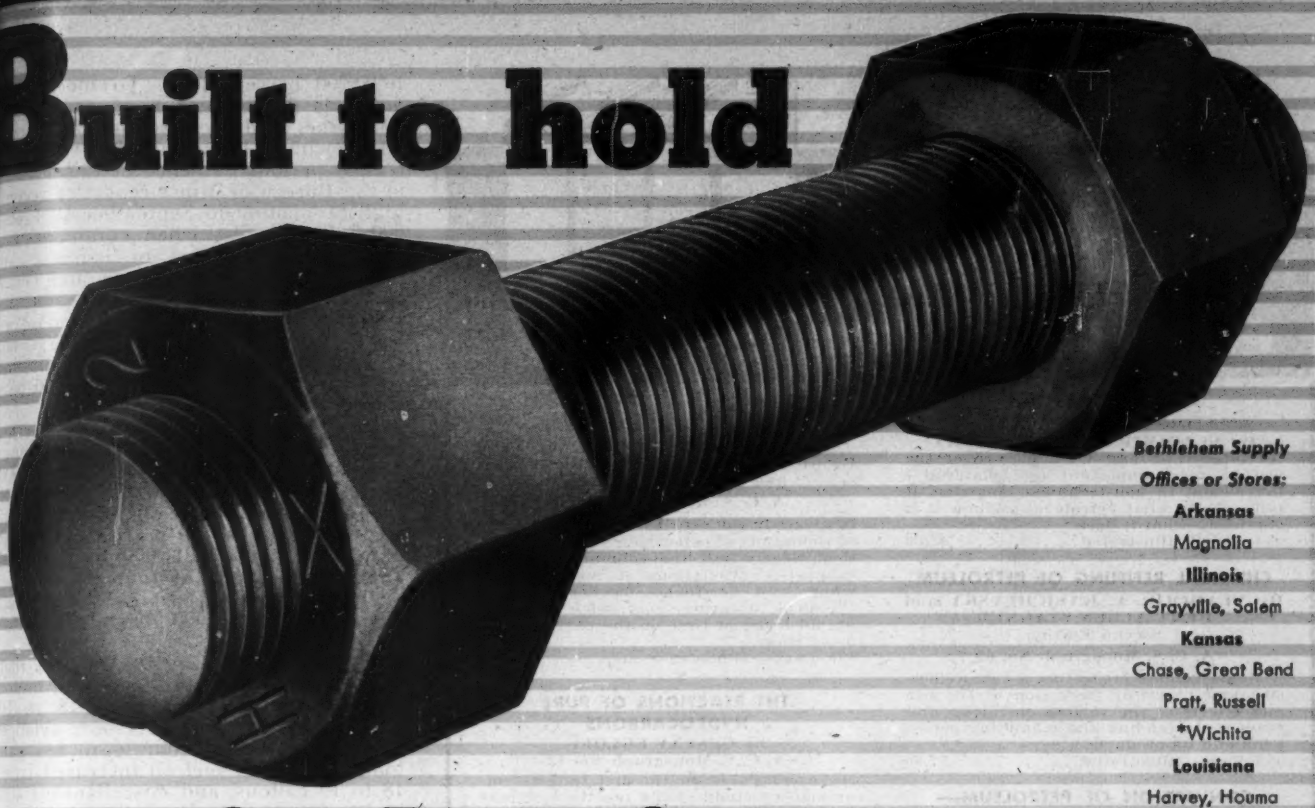
The agreements, it was explained, will make available to the industry several alternative types of licenses under the hydrogenation patents in addition to the licenses provided under the consent decree.

The order does not in any way affect the obligation of Standard Oil Company (New Jersey) under the decree to issue licenses under all of its hydrogenation patents, royalty free for the duration of the war and six months thereafter and at reasonable royalties for their remaining life, nor does it in any way affect the issue of the ownership of patents emanating from I. G. Farbenindustrie, now in litigation between the company and the Alien Property Custodian, the department said.

Military Gasoline Needs Up Fivefold Since 1941

Increase of military requirements for gasoline from 150,000 to 800,000 barrels daily has been shown by Petroleum Administration for War as the reason civilian gasoline rations cannot be increased at this time. The same report to the public revealed that production of crude oil and refinery runs had been increased to more than 4,700,000 barrels daily. Gasoline accounts for approximately half of the total of all oils used in fighting the war, which is taking

Built to hold



at vital points

A stud bolt is a very tiny fraction of a petro-chemical plant. Yet many thousands of them go into the building and maintenance of such a plant. The failure of even a few, resulting in leakage, creates a fire hazard that can lead to disaster.

That's why Bethlehem stud bolts and hot-forged nuts are made to meet such exacting quality standards. When you specify them you're getting the benefit of expert metallurgy, correct heat-treating, and the most up-to-date methods of manufacture.

Bethlehem has recently begun the manufacture of heat-treated carbon steel studs conforming to the new ASTM specification A 261-43T. For higher temperatures and pressures, alloy steel stud bolts are also available through Bethlehem Supply stores in refinery centers. These alloy types include grades B7 (4140) and B7a (4140 with higher molybdenum) of ASTM specification A 193-40T.

Attached to Bethlehem Supply stores are highly trained experts who know refinery practice. They know, for instance, what fastenings to recommend for use at high temperatures and high pressures, and combinations of both; for extra-heavy duties, off-trail jobs, etc.

This is the kind of service you can expect—and the kind you will get—when you call up a Bethlehem Supply man.

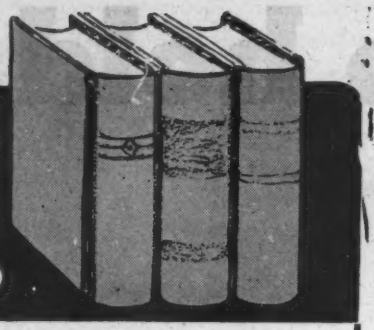
Bethlehem Supply Offices or Stores:

Arkansas
Magnolia
Illinois
Grayville, Salem
Kansas
Chase, Great Bend
Pratt, Russell
*Wichita
Louisiana
Harvey, Houma
Lake Charles, New Iberia
Shreveport
Mississippi
Laurel
New Mexico
Artesia, Hobbs
Oklahoma
Oklahoma City, *Ponca City
Seminole
Tulsa, Wewoka
Texas
Alice, *Amarillo
*Beaumont, Borger
Bowie, Corpus Christi
*Dallas, *Fort Worth
Graham
Houston, Kamay
Kermit, Kilgore
La Ward, Odessa
Pampa, *San Antonio
Sundown
Wichita Falls
Winnsboro

*Office only

BETHLEHEM STEEL

GHQ FOR REFINERY SUPPLIES



REINHOLD BOOKS in the PETROLEUM FIELD

AMAZING PETROLEUM INDUSTRY
By VLADIMIR A. KALICHEVSKY
An interesting and vivid picture of the world's most important raw material—Petroleum. In non-technical language, it tells simply what petroleum is—how it is obtained—what it does.
234 Pages. Illustrated.....$2.25

CHEMICAL REFINING OF PETROLEUM
By VLADIMIR A. KALICHEVSKY and BERT ALLEN STAGNER
Second Edition
A. C. S. Monograph No. 63
A single volume presenting a comprehensive and practical discussion of the use and effects of the various chemicals and reagents in refining and modifying petroleum and its products.
550 Pages. Illustrated.....$7.50

CONVERSION OF PETROLEUM—
Production of Motor Fuels by Thermal and Catalytic Processes
By A. N. SACHANEN
Complete, up-to-the-minute discussion of the recent discoveries in the field. Includes: high-octane fuels; catalytic hydrogenation or polymerization of by-product gases; degumming agents; tetra-ethyl lead as an anti-knock agent; synthesis of aromatic hydrocarbons from paraffins.
413 Pages. Illustrated.....$6.00

CHEMISTRY OF PETROLEUM DERIVATIVES
By CARLETON ELLIS
A veritable encyclopedia of the mass of material concerned with the development and utilization of the derivatives of natural gas and petroleum.
Volume I—1,285 Pages. Illustrated $18.00
Volume II—1,464 Pages. Illustrated $20.00

MODERN METHODS OF REFINING LUBRICATING OILS
By VLADIMIR A. KALICHEVSKY
A. C. S. Monograph No. 76
Includes: Properties of refined oils. Modern refining methods. Petroleum waxes. De-waxing. Asphaltic substances. Conventional de-asphalting methods. Solvent refining processes. Single, mixed, double solvents. Viscosity. Oxidation. Fluorescence.
253 Pages $6.00

LUBRICATING GREASES:
Their Manufacture and Use
By E. N. KLEMGARD
A complete presentation of practical and scientific data, including the chemical analyses of many commercial lubricants; abstracts of outstanding patents; formulae, manufacturing processes; plant management and equipment; grease bases and extreme-pressure compounds.
873 Pages. Illustrated.....$15.00

ISOMERIZATION OF PURE HYDROCARBONS
By GUSTAV EGLOFF, GEORGE HULLA and V. I. KOMAREWSKY
A. C. S. Monograph No. 88
It covers in the greatest detail the results of thousands of experiments in isomerization. Nearly half the volume consists of exhaustive tabulations of reaction data which can be found nowhere else in chemical literature, and which will save untold hours of time on the part of those using them.
499 Pages. Illustrated.....$9.00

THE REACTIONS OF PURE HYDROCARBONS
By GUSTAV EGLOFF
A. C. S. Monograph No. 73
Makes available for the first time a comprehensive study of the reactions of pure hydrocarbons resulting from thermal, catalytic, photochemical, and electrical treatment.
879 Pages. Illustrated.....$16.75

PHYSICAL CONSTANTS OF HYDROCARBONS
By GUSTAV EGLOFF
A. C. S. Monograph No. 78
The scope of this work is such that it may be utilized in pure and applied science and in industries such as petroleum, natural and manufactured gas, chemical, rubber, plastic, resin and pharmaceutical.
Volume I—Paraffins, Olefins, Acetylenes, and other Aliphatic Hydrocarbons. 416 Pages $9.00
Volume II—Cyclanes, Cyclenes, Cyclynes, and other Alicyclic Hydrocarbons. 608 Pages $12.00

CATALYSIS—Inorganic and Organic
By SOPHIA BERKMAN, JACQUES C. MORRELL, and GUSTAV EGLOFF
Shows the importance of Catalysis to industry by discussing the process in the production of aviation fuel, high explosives, synthetic rubber, dyes, medicinals, pharmaceuticals, perfumes, edible fats and oils and other products hitherto derived from coal tar.
1,150 Pages. Illustrated.....$18.00

EMULSIONS AND FOAMS
By SOPHIA BERKMAN and GUSTAV EGLOFF
This clearly-written and well-digested review of the present knowledge of the subject assembles and evaluates the recent advances in the technology of these phenomena. Diagrams and photomicrographs bring home with unique emphasis the electrostatic forces at work in the phenomena of interfacial tension, phase inversion and film rigidity.
591 Pages. Illustrated.....$8.50

10-DAY APPROVAL COUPON

REINHOLD PUBLISHING CORP.
330 West 42nd St., New York 18, N. Y.
Please send on ten days' approval the books indicated on the attached sheet. At the end of that time, if I decide to keep the books, I will remit indicated price plus postage; otherwise I shall return the books postpaid.

Name_____
Address_____
City_____ State_____
Employer_____ PR-12-44

☐ Send Free Catalog listing over 200 scientific books.

1,600,000 barrels daily. To meet these demands it has been necessary to call upon the fields to produce at a rate which cannot be sustained over an extended period. Evidence of this is seen in the Bureau of Mines report of record high production in September at 4,766,000 barrels daily, when comment was made that the total of increases in crude-oil output in California and Texas was greater than the increase for the country as a whole. The bureau report for September also showed refinery runs at a peak of 4,789,700 barrels daily, involving a draft on stocks of 23,400 barrels of crude daily.

Stocks at the close of September included 222,868,000 barrels of gasoline-bearing crude oil, against 223,901,000 barrels August 31; 6,469,000 barrels of California heavy crude oil, against 6,291,000 barrels; 4,141,000 barrels of natural gasoline, against 4,211,000 barrels, and 253,014,000 barrels of refined products, against 245,390,000 barrels. Total of all oils was 486,492,000 barrels, against 479,793,000 barrels.

Figures prepared by PAW show that since Pearl Harbor production of motor gasoline has declined from 18 to 10 gallons of crude oil processed; aviation gasoline increased from ½ to 6½ gallons per barrel; fuel oil increased from 18 to 19 gallons, and miscellaneous and losses, 6½ against 5½ gallons.

Bureau Reviews Progress Of Synthetic Fuel Research

United States Bureau of Mines has released a review of its research during the past eight years in making liquid fuel from coal and lignite. This preliminary research is the basis upon which the bureau has launched its current five-year program of advanced research and development under which laboratories and demonstration plants are being built.

Prepared by Dr. Arno C. Fieldner, chief of the fuels and explosives branch, Dr. Henry H. Storch, supervising chemist, and Dr. Lester L. Hirst, physical chemist, the review explains in detail the experiments in hydrogenation and liquefaction conducted at the bureau's laboratory-scale plant at Pittsburgh, a continuous unit capable of hydrogenating 100 pounds of coal in 24 hours. It also presents chemical-process information obtained in a large number of batch-hydrogenation tests conducted in small steel autoclaves.

Fifteen coals obtained from beds in 11 states and Alaska and ranging in rank from lignite to high volatile bituminous were tested in the experimental plant, and the results are presented in tabular form.

Physical characteristics and chemical compositions of the oils from the various coals were found to be influenced principally by operating conditions. These oils, readily converted to gasoline by high pressure hydrogenation, also provide chemicals of commercial value, such as tar acids for plastics and benzene, toluene, and xylene for explosives and solvents. The yield of tar acids and tar bases is about 10 times that obtained in coal carbonization, the authors state.

They explain the apparatus and experimental procedure employed for both batch hydrogenation in rotating autoclaves and continuous hydrogenation in a 3-inch converter unit as well as the characteristics of the oils produced.

A condensed version of this report

Let our experience help you

PATTERSON

PATTERSON ENGINEERING SERVICE

PATTERSON SATISFACTORY MACHINERY

--For TOMORROW'S better petroleum products

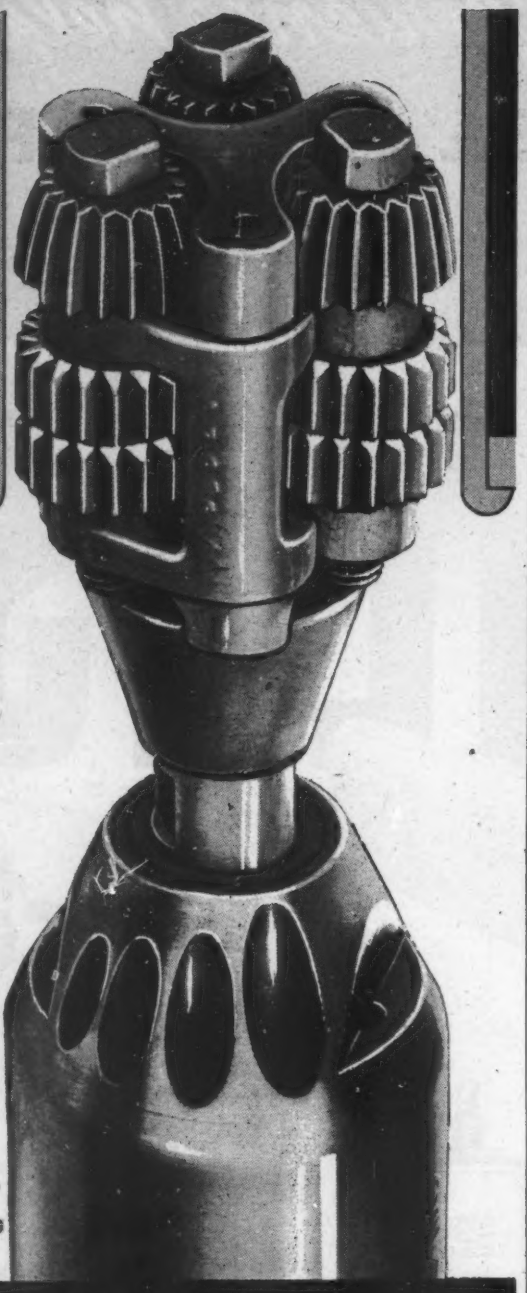
Richard L. Cameron
President

SATISFACTORY PATTERSON MACHINERY

THE PATTERSON FOUNDRY & MACHINE CO.

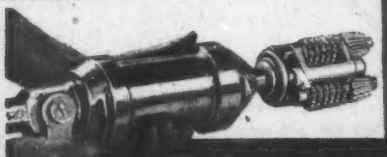
EAST LIVERPOOL, OHIO, U. S. A.

Do your men clean the FRONT ends of tubes?



With ordinary tube cleaners, cleaning the front ends of tubes is a dangerous operation, even with perfect coordination between operator and helper. There is a natural tendency to insert the cleaner far enough inside the tube to eliminate any danger from revolving cutters when the air is turned on, thus leaving the front ends of tubes uncleaned.

With a Roto Tube Cleaner equipped with air valve directly behind the motor, the operator himself turns the air on and off. This positive one-man control permits him to turn on as much air as he needs, whenever he needs it, and he can clean right up to the end of the tube with complete safety. Get details of these time- and labor-saving tube cleaners.



ROTO Tube Cleaners

The ROTO Company, 145 Sussex Ave., Newark 1, N. J.

DIVISION OF ELLIOTT COMPANY

You'll have to use your tube cleaners sooner or later, perhaps sooner than you expect. So why risk tying up production on account of imperfect tube cleaners? Get them ready for immediate action now. If they need adjustment, repair or replacement parts, let us take care of your needs.

was presented by Dr. Fieldner at a recent meeting of the American Institute of Mining and Metallurgical Engineers at New York.

An unabridged copy of the publication, Technical Paper 666, "Bureau of Mines Research on the Hydrogenation and Liquefaction of Coal and Lignite," may be obtained from the Superintendent of Documents, Government Printing Office, Washington 25, D. C., for 15 cents. It is not for sale by the Bureau of Mines.

Refinery Workers Safer at Work

Standard Oil Company (Indiana) safety men have shown by a painstaking survey of the thousands of workers at the Whiting refinery, that men are safest when on the job. During the first 9 months of 1944 there were 16 disabling accidents in the plant, and during the same period 56 were hurt while off duty—24 of them when the workers were at home and 21 in traffic. The company is publicizing these figures in its campaign to get men to work in the plant. Prospective employes are inclined to magnify the danger of working around gasoline and explosive ingredients, but the figures show they are safer there.

France Good Customer For Oil After War

Foreign Economic Administration has estimated that France will be in the market for $63,000,000 worth of petroleum products and $5,000,000 in synthetic rubber and carbon black during the first year, after the war is over in Europe. During that period the French government will be the only import purchaser. The report did not deal with the problem of rehabilitating French refining plants and the probable source of materials for that purpose. French internal financial affairs, it said, are seriously disorganized, but the government has substantial credit reserves in the United States.

America Must Supply Refinery Replacements

The Foreign Economic Administration is interested in the oil industry and already has representatives abroad looking into the needs of the liberated countries for equipment with which to revive their refinery and other operations.

Indications are that Allied bombing of oil plants will result in heavy requirements of American equipment to rebuild refineries in European countries, and this will be one of the first steps necessary in the program to put the liberated areas on their feet again.

PAW to Handle Allocation Of Railroad Tank Cars

Shifting of more than 12,000 tank cars from East to West Coast service and conversion of 1000 cars to acid service has developed a situation under which it is contemplated a priority system under which who will ship what, where and when will be regulated. A two-day conference between Office of Defense Transportation and Petroleum Administration for War officials brought out need for the regulation and announcement that the latter probably will regulate movement of the cars.

FRANKLIN Selective Procurement Service

DISTRIBUTING

- **Republic Tubing & Line Pipe**
- **Walworth Valves and Fittings**
- **Brown Fintube Heat Exchangers**
- **Fairbanks-Morse Engines**
- **Macwhyte Wire Rope**
- **United States Rubber Goods**
- **Worthington Pumps and Machinery**
- **Babcock & Wilcox Tubing**

Here's a complete, well planned Supplying Service, designed specifically to "take the load off" busy oil men whose job is to "get the stuff on the job."

Many such men use Franklin Service — and like it, for one simple reason: it works.

You find here a group of men who know "who needs what" in the oil industry — and where to find whatever it is you're looking for. That "buying experience" helps you not only on the regular lines we represent but on emergency requirements for specialty items.

Better test it some time.

FRANKLIN SUPPLY COMPANY

600 SOUTH MICHIGAN AVENUE, CHICAGO 5, ILLINOIS

Abstracts of Petroleum Papers Read Before American Institute of Chemical Engineers

Lawrence W. Bass, associate director of chemical research of both Air Reduction Company and U. S. Industrial Chemicals, Inc., New York, was elected president of the American Institute of Chemical Engineers at its thirty-seventh annual meeting in St. Louis, November 19-22.

Abstracts of the papers, which have application to the petroleum industry, as presented on the program are offered below.

The Production and Purification of Butadiene from Alcohol. W. S. Brackett and J. L. Marsh, Carbide & Carbon Chemicals Corporation, South Charleston, West Virginia.

The process now used for large-scale production of butadiene from alcohol was developed in Carbide and Carbon Chemicals Corporation's research laboratories in 1940-41. The total rated capacity of the plants using this process is 220,000 tons per year. Improvement of the catalyst by continued research between the initial design of the plants and their completion, plus perfection of manufacturing technique through experience with the large-scale operations, have resulted in productions considerably greater than the design capacity. In the second quarter of 1944, the production of butadiene from alcohol was at the rate of about 396,000 tons per year. Of all the butadiene produced in government-owned plants, through June, 1944, 75 percent was from alcohol.

The Carbide and Carbon Chemicals Corporation's process consists primarily of the reaction of one mol of alcohol with one mol of acetaldehyde to form one mol of butadiene plus two mols of water. Acetaldehyde is manufactured by the dehydrogenation of alcohol. The reactions take place at elevated temperatures and substantially atmospheric pressure. Conversion is not complete. Reaction products are separated by distillation and unreacted materials are returned to the process. Butadiene is purified by treatment with "Chlorex" and subsequent distillation. In the wartime plants, built without complete by-product recovery equipment to save investment in money and critical materials, the actual efficiency from alcohol, to the butadiene contained in the product, is 61.6 percent. By installing additional equipment for recovering useful by-products for use as such, or for reconversion into alcohol, the practical efficiency from alcohol to butadiene and by-products can be brought up to about 75 percent.

The Production of Butadiene by Dehydrogenation of Normal Butylenes. R. P. Russell, E. V. Murphree, Standard Oil Development Company, New York, and W. C. Asbury, Standard Oil Development Company, Elizabeth, New Jersey.

Seven plants having a combined rated capacity of over 300,000 tons per year are producing butadiene from normal butylenes using the process developed by Standard Oil Company (New Jersey). The Jersey process employs a new type of dehydrogenation catalyst which is active in the presence of steam and hence permits the use of steam both to supply the heat for the highly endothermic reaction and to reduce the partial pressure of the butylenes. The commercial operation involves the catalytic dehydrogenation at high temperatures of a selected refinery C_4 cut rich in normal butylenes. The reactor products are quenched, water is separated, and the hydrocarbons are compressed. After removing hydrogen and light hydrocarbons the C_4 stream is distilled, solvent extracted to remove butadiene, and unreacted butylene is recycled to the reactor.

Laboratory and process design studies were carried on simultaneously during 1941, and shortly before the United States entered the war plans for large-scale plants were in progress. A 10-ton-per-day demonstration plant was operated in the spring of 1943. In February, 1942, details of the steam dilution process were disclosed to the Butadiene Producers Committee and the Rubber Reserve Corporation, and this process was selected by the majority of the petroleum butadiene producers.

The first plant, constructed at Baton Rouge, Louisiana, was put on stream in May, 1943, and for the first 15 months has produced 120 percent of its rated capacity. As experience accumulated, the operation was steadily improved and during the fourth run, lasting 89 days, average production was 139 percent of design and the design utilization factor of 0.61 pounds of recovered butadiene per pound of butylene disappearance was attained. No serious mechanical or operating difficulties have been encountered.

The investment for a plant of this type under wartime conditions is about $385 per ton per year of butadiene, but will vary somewhat depending on local conditions and the scale of operation. Postwar competitive butadiene prices are estimated to be about 8-10 cents per pound for this process.

The Design and Operating Features of Houdry Fixed-Bed Catalytic-Cracking Units. R. H. Newton, Catalytic Development Corporation, Marcus Hook, Pennsylvania.

The Houdry fixed-bed catalytic-cracking process has a number of distinctive engineering features, to which the successful commercial functioning of this complex large-scale operation is in great measure due. The oil to be cracked and the air for regeneration of the catalyst are alternately passed through a bed of pelleted catalyst. The catalyst case is constructed to provide positive distribution of the vapors throughout the catalyst mass, and is equipped with finned heat-transfer elements for control of temperature and removal of heat. The alternate oil and air cycles make it necessary to purge the catalyst before and after each operation. The purging is accomplished by evacuation. The cyclic operation is carried out with three or more catalyst vessels so that the flow of both oil and air are continuous. The flow of vapors is controlled by specially constructed motor-operated valves which are governored by a 900-point automatic cycle timer.

The heat control of the catalyst vessels is accomplished by circulating an inorganic salt heat transfer medium. Because of the high heat-transfer coefficients obtained it is feasible to control the catalyst temperature within a maximum difference of about 200° F. of the salt temperature and to develop 450 pound steam with excess heat.

To promote rapidity of combustion of the carbon deposit, and permit maximum utilization of the catalyst, air at about 45 pounds pressure is used for regeneration. The hot fumes from the cases are expanded through a gas turbine which develops the power required for compression as well as power to drive an electric generator. The cracking plant can be made substantially self-contained in its power and steam requirements.

The precision of control of catalyst temperature, and the flexibility of the equipment, especially with respect to pressure of operation is noteworthy.

Improved Fluid Process for Catalytic Cracking. E. V. Murphree, Standard Oil Development Company, New York, C. L. Brown, Esso Laboratories, Standard Oil Company of Louisiana, Baton Rouge, C. E. Jahnig, E. J. Gohr, H. Z. Martin and C. W. Tyson, Esso Laboratories, Standard Oil Development Company, Elizabeth, New Jersey.

An improved design of the Fluid catalyst process for the cracking of petroleum is described. The new method, now in widespread commercial use, provides major simplifications and improvements over the process as previously disclosed. Recovery of solid catalytic materials from gas streams is greatly simplified, facilitating circulation of extremely large amounts of solids. Increased flexibility in control of the degree of catalytic treatment is provided. Vaporized charge stocks are not required permitting utilization of difficultly vaporizable feed materials. A description of the component parts of the equipment and the results of commercial catalytic-cracking operations are included. The Fluid-catalyst-cracking process, already a major source of 100-octane gasoline, represents a new technique in chemical engineering, and wide application to other industrial processes is anticipated.

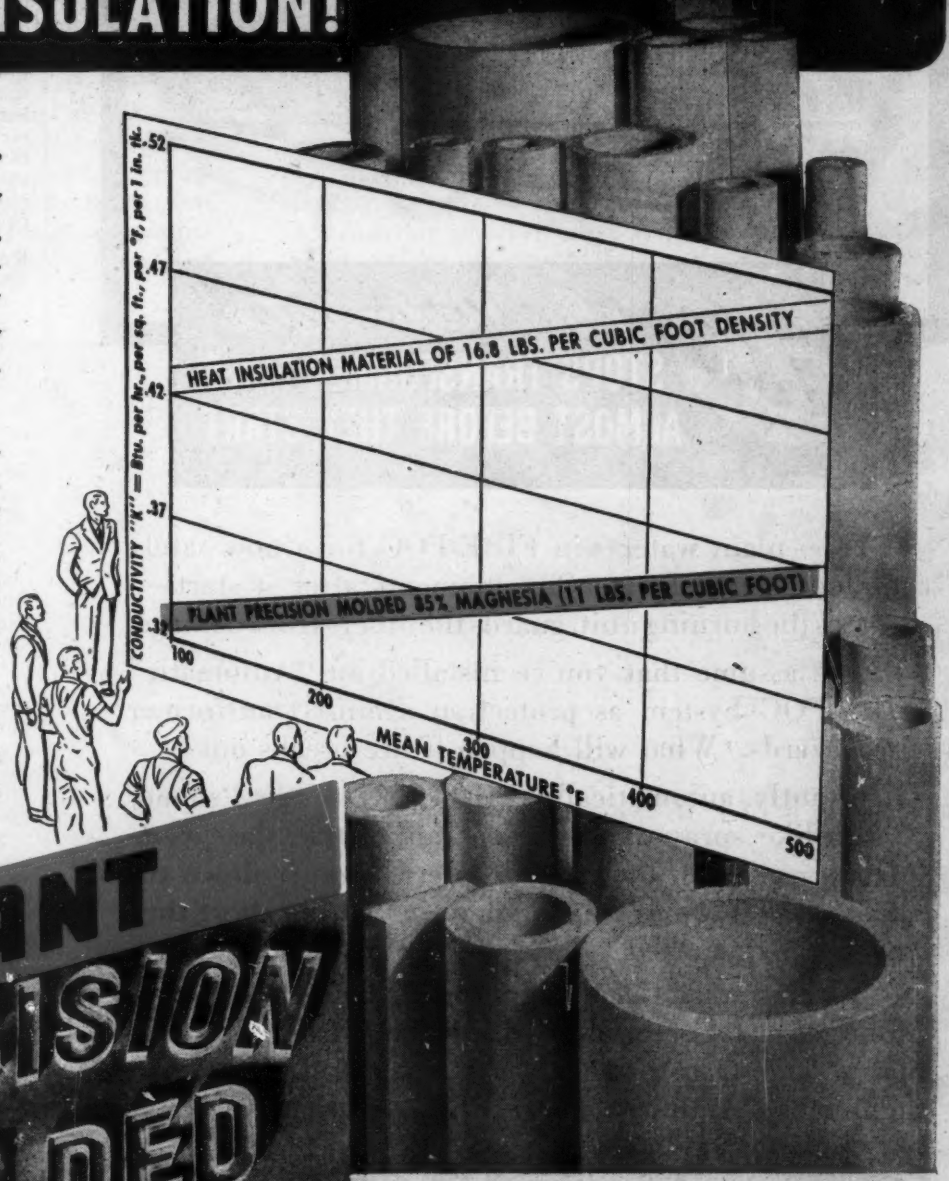
The TCC Catalytic Cracking Process for Motor Gasoline Production. R. H. Newton, Catalytic Development Corporation, Marcus Hook, Pennsylvania, G. S. Dunham, Socony-Vacuum Oil Company, New York, and T. P. Simpson, Socony-Vacuum Oil Company, Paulsboro, New Jersey.

The catalytic cracking of petroleum has been in successful commercial operation for eight years. Although the basic fundamentals of catalytic cracking are not extremely complex, the engineering details necessary to successful commercial operation have required a vast amount of study. The TCC process is characterized by separation of the reaction and regeneration zones and continuous movement of a solid catalyst through each. The problems of uniform contact of the catalyst with the reacting vapors, isolation of the reaction and regeneration systems, maintenance of thermal balance by addition and removal of heat and instrumentation and

LIGHT DENSITY TYPE PRECISION MOLDED 85% MAGNESIA brings New, Greater Efficiency in HEAT INSULATION!

Fuel savings reach a new "high," and heat losses drop to a new "low"! — Because this new, light-density type of 85% Magnesia sets a remarkable new standard of insulating efficiency over the full range of temperatures!

Plant Precision Molded process* has revolutionized the natural insulation superiorities of 85% Magnesia. Plant Precision Molded 85% Magnesia is easier to handle—it goes on faster, and brings the advantages of great "ductile strength," controlled uniformity and precision pipe fit. It's *tomorrow's* heat insulating material, and it's here *today*. Write now for complete data.



PLANT PRECISION MOLDED 85% MAGNESIA "THE DEPENDABLE STANDARD—MODERNIZED" REG. U.S PAT. OFF.

*Patents Nos. 2,131,374, 2,209,752, 2,209,753, 2,209,754

COMPLETE RANGE OF SIZES and thicknesses in blocks and pipe coverings (up to and including 18 inch pipe size in sectional form. Larger sizes in segmental form.)

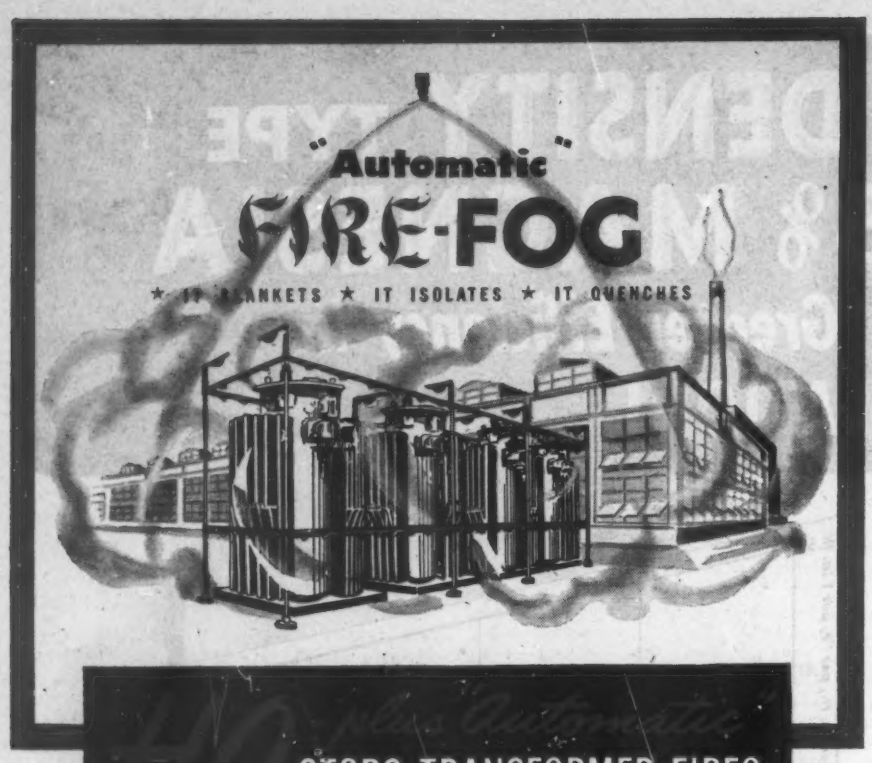
Army-Navy "E" Awarded to FACTORY No. 1 Emeryville, Calif.

PLANT RUBBER & ASBESTOS WORKS

MAIN OFFICE: SAN FRANCISCO

Sales Offices in Los Angeles, Wilmington, and Oakland, Calif.; distributors in principal cities. *Factories* in Emeryville, San Francisco, and Redwood City, Calif.

Manufacturers of Plant Insulating Materials and Mechanical Packings Since 1920



STOPS TRANSFORMER FIRES ALMOST BEFORE THEY START

● Yes—plain water—in FIRE-FOG form now safely puts out a transformer fire moments after it starts—isolates the burning unit, guards the others from damage.

Let's assume that you've installed an "Automatic" FIRE-FOG System as protection against transformer fire hazards. What will happen if fire breaks out?

Instantly, automatically, FIRE-FOG nozzles "shoot" a mist-like spray at the fire, blanket the blaze completely—millions of water droplets hammer down the flames—cool the fire area. In an incredibly short time the fire is quenched

. . . and a costly conflagration—plant shut-down—production loss, are all avoided thanks to plain, ordinary water transformed into a potent all-around fire fighter by "Automatic."

★ YOUR FIRE HAZARD? You need a FIRE-FOG installation for protection from fires resulting from ignition of vapors caused by leaks or breaks in petroleum processing and storage equipments. Write for complete information—we'll send it to you promptly.

"AUTOMATIC" manufactures and installs a complete line of fire protection devices and systems for all types of fire hazards.

"Automatic" SPRINKLER CORPORATION OF AMERICA

YOUNGSTOWN, OHIO . . . OFFICES IN 31 CITIES

control for convenient and safe operation have been the subject of intense study. The factors governing rate of flow of pellet catalyst in beds, and methods of insuring uniform flow and distribution have been studied experimentally in plant-scale models. The characteristics of the cracking catalyst require a minimum temperature of about 900° F. to burn off the coke deposit in order to regenerate the catalyst and also dictate a maximum temperature of not over about 1200° F. in order not to damage the catalyst. These requirements are satisfied by stepwise burning and cooling, and limiting the temperature in any zone by control of the oxygen supplied.

It is believed that the characteristic design of equipment and the application of simple engineering principles is not limited to the cracking of petroleum. Wherever a solid catalyst is contacted with vapor in a regenerative process and the reaction pressures do not exceed approximately 2 or 3 atmospheres, the TCC principle would appear to be applicable.

Routine Analysis with the Mass Spectrometer. John A. Hipple, Westinghouse Electric Manufacturing Company, East Pittsburgh, Pennsylvania.

In the development of a mass spectrometer for routine analyses, various problems must be solved in addition to those encountered in the design of a laboratory instrument of limited application. These may be roughly divided into the following classes:

(1) Electronic control. The operator should be able to ignore the electrical circuits during analyses.

(2) Gas-flow problems. These involve such problems as linearity of the throttling device with partial pressure of each component, constancy of pumping speed, and adsorption on the walls.

(3) The effect of various factors on the spectra of pure compounds. The temperature of the ion source is one of particular importance here.

(4) Recording. A recorder of wide range and high speed is essential for effective use of the equipment. Preferably this should be a pen-recording system.

A mass spectrometer is described with special emphasis on the manner in which the above problems have been solved.

The second portion of the paper deals with analytical methods. There are at present about five different general methods available to be used in making analyses with the mass spectrometer. These are discussed in detail and their relative merits appraised.

Industrial Mass Spectrometry. Harold W. Washburn, H. F. Wiley, S. M. Rock, and C. E. Berry, Consolidated Engineering Corporation, Pasadena, California.

The analysis of gas and liquid mixtures by the mass spectrometer has proved itself to be of considerable value in the petroleum industry. Essentially this new method consists of the determination of the composition of a mixture from its mass spectrum and a knowledge of the mass spectra of the components in that mixture.

The mass spectrum of a pure substance may be defined as a plot of the relative abundances of positive ions formed at different masses when the substance in vapor form is bombarded by electrons. The mass spectrum of a substance is found to depend upon its molecular structure as well as upon the

Double Duty at Aviation Gasoline Plants

ALL-OUT production of 100-octane gasoline has called for *all-out* protection of the components of this product. At the huge aviation gasoline plant where these pictures were taken, a portion of the capacity is devoted to the hydrogenation of selective polymer shipped from other plants and part of the hydro capacity is being used for producing high-octane aviation base stock. Hortonspheres are performing a double duty at this location as at many other aviation gasoline plants. These pressure spheres protect the volatile components of 100-octane gasoline from evaporation loss during their handling and storing. They also go a step further and guard the inherent quality of the products.

Hortonspheres operate on the principle that venting and accompanying vapor loss will not take place as long as the pressure in the vapor space does not exceed the setting of the relief valve. Use Hortonspheres for efficient storage of butane, isobutane, alkylate and even the finished fuel itself.

Write our nearest office for information or quotations on storage tanks of all types.

The Hortonsphere shown on the opposite page and those at the left are located at a leading aviation gasoline plant. They hold 2,500 bbls. each and are designed to operate at 75 lbs. per sq. in. pressure. The Hortonsphere shown below, at the same location, holds 10,000 bbls. and operates at 75 lbs. per sq. in. pressure.

YOU CAN USE THE HORTONSPHERE . . .

for the storage of many volatile liquids and gases. In addition to butane, isobutane and alkylate, Hortonspheres are being used to store butadiene and other volatile petroleum products at synthetic rubber plants.

Hortonspheres are built in capacities of 1,000 to 20,000 bbls. for pressures from 20 to 100 lbs. per sq. in. for liquids . . . and up to 65 ft. in diam. for pressures from 20 to 100 lbs. per sq. in. for gases. The smaller sizes may be designed for higher pressures up to 250 lbs. per sq. in.

& IRON COMPANY

NEW YORK • PHILADELPHIA • SAN FRANCISCO
TULSA • WASHINGTON

Royal Crown PUMP VALVES
ARE STREAMLINED TO THE FLOW
THEY ROTATE, SWING, AND SEAT
at the will of varying side pressures
from the fluid being pumped.
NO SPRINGS ARE REQUIRED to force
the valve to seat—the cup-like top
of the valve makes it close instantly.
RC VALVES ARE AVAILABLE in all
sizes, all metals. Valve and seat are
factory ground and lapped together.
MADSEN IRON WORKS
HUNTINGTON PARK, CALIFORNIA

Distributors:
L. B. STANLEY—HOUSTON, TEXAS
HOWARD SUPPLY CO.—CALIFORNIA

number and kind of atoms forming its molecules. Generally speaking, then, there is a one-to-one correspondence between a substance and the mass spectrum of that substance. This characteristic permits the analysis of a mixture from its mass spectrum even though some of the components of the mixture are isomers.

The contribution to each peak in the mass spectrum of a mixture resulting from a particular component of a mixture is proportional to the partial pressure of that component in the mixture. In other words, the mixture mass spectrum is a linear superposition of the mass spectra of the components of that mixture. It follows that the analysis of a mixture can be made from its mass spectrum by solving a set of linear simultaneous equations.

The characteristics of the mass spectra of the components of many common mixtures such as depropanizer overheads, depropanizer bottoms and debutanizer overheads permit the rapid determination of the key components. In these cases the computation time is less than ten minutes and the instrument time approximately twenty minutes.

Empirical constants were obtained by averaging the errors observed upon running a large number of synthetic samples contain C_1 through C_4 paraffins and olefins. These empirical constants are used in predicting the accuracy of analyzing a mixture for which synthetic mixtures have not been run, but for which the mass spectra of each of the components have been obtained.

Experience obtained from both commercial and laboratory operation of the instrument has shown that the mass spectrometer method is well adapted to (1) the determination of small amounts of a substance (contaminent) in a mixture or a pure substance (2) the analysis of mixtures containing hydrogen, helium, nitrogen, etc. (3) the analysis of wide range mixtures such as hydrogen and C_1-C_5 paraffin olefin mixtures obtained from a cracking still overhead (4) determination of key components from simple mixtures such as butadiene and styrene in a mixture containing C_4 and C_5 olefins and diaolefins, styrene, ethylbenzene, and butadiene dimers (5) analyses of mixtures containing a large number of isomers such as a mixture of C_6 paraffins and cyclics.

Although there has been no commercial application to C_7 and C_8 mixtures to date, laboratory data indicates that the mass spectrometer may make possible the routine analysis of complex C_7 or C_8 mixtures such as the C_8 fraction of an aviation alkylate.

Styrene Production by Catalytic Dehydrogenation Low Pressure Operation. Julian M. Mavity, Earl E. Zetterholm, and George Hervert, Universal Oil Products Company, Riverside, Illinois.

The catalytic dehydrogenation of ethylbenzene to styrene is discussed with particular regard to the effect of the operating variables pressure, temperature, space velocity, and process period length on conversion, styrene yield, and extent of carbon deposition. Correlations based on laboratory scale experiments using U.O.P. commercial dehydrogenation catalyst show favorable effects from reduction of pressure or from increase in temperature within the respective ranges investigated (80 mm. absolute to 50 pounds per square inch gauge, and 550° to 630° C.). The process is quite selective, with indicated ultimate yields as high as 90 percent.

Agitation of Two-Phase Systems of Immiscible Liquids. Shelby A. Miller* and Charles A. Mann, University of Minnesota, Minneapolis, Minnesota.

Power data for seven designs of agitators operating in homogenous liquids and in two-phase liquid mixtures in unbaffled tanks are presented. The power required to agitate a system of two immiscible liquids may be correlated by the familiar power function—Reynolds number plot, if the average density of the mixture and a weighted geometric mean of the viscosities of the two phases are used in calculating these functions.

Degree of mixing data, evaluated by a sampling scheme, are reported in terms of the Hixson-Tenney mixing index, modified to suit the conditions of this study. The effects of liquid depth, agitator clearance, interface level, and oil-phase properties on the degree of mixing and the power requirement for each of the impellers are evaluated.

It is shown that laboratory tests of the agitation of two-phase liquid mixtures can be scaled up successfully by designing larger equipment which is geometrically similar to that used in the laboratory and by applying equal power per unit volume in both sizes.

Liquid-Liquid Extraction in a Perforated Plate Column. R. W. Moulton, University of Washington, Seattle, Washington, and John E. Walkey, University of Texas, Austin, Texas.

Equilibrium distribution data are reported for the system: 2, 2, 4—trimethylpentane—methyl ethyl ketone—water and the system: gasoline—methyl ethyl ketone—water at 25.0° C. together with the method of analysis.

A 3.75-inch perforated plate countercurrent liquid—liquid extraction column has been operated for the extraction of methyl ethyl ketone from mixtures of gasoline and methyl ethyl ketone corresponding to the azeotropic distillate formed in the system: toluene—gasoline—methyl ethyl ketone. The operating behavior of the tower has been evaluated, and the plate efficiencies are reported for this non-ideal system. The ratio of the solvent rate to the feed rate has been found to be an important variable in the efficiency of continuous countercurrent liquid—liquid extraction towers.

Pennsylvania Association Studies Postwar Problem

Pennsylvania Grade Crude Oil Association, through its directors meeting at Oil City November 16, has appointed a committee to study marketing problems in the postwar period. D. T. Andrus, president, appointed the following committee: J. B. Fisher, H. A. Logan, Samuel Messer, C. L. Suhr and A. W. Scott.

J. P. Jones, director of production, reported progress in establishing a laboratory at Bradford to facilitate crude oil production research.

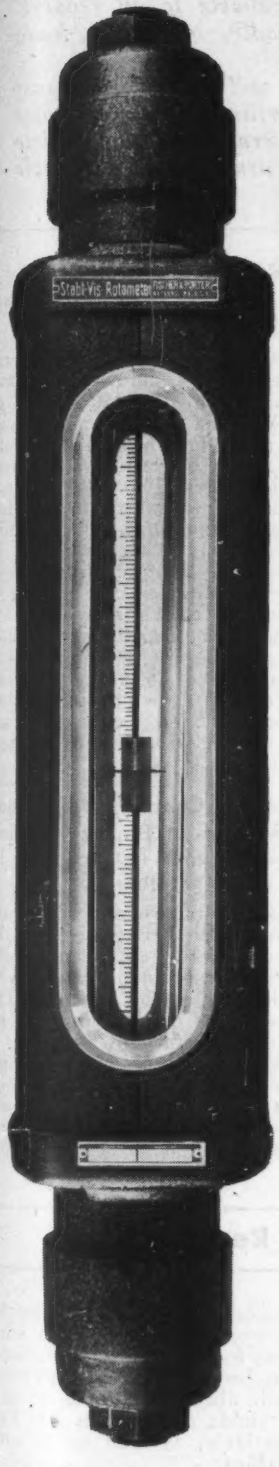
Fayette B. Dow, general counsel reported, with satisfaction to the directors, a case wherein the Federal Trade Commission had issued a cease and desist order against a company which is alleged to have falsely represented its product to be Pennsylvania oil.

* Present address. Engineering Department, Experimental Station, E. I. duPont de Nemours & Company, Wilmington, Delaware.

Here is the ROTAMETER with every flow-measuring feature you asked for!

THE NEW *Master-Enclosed*

ROTAMETER



The Master Enclosed Rotameter with screwed connections. Flanged connections are also available.

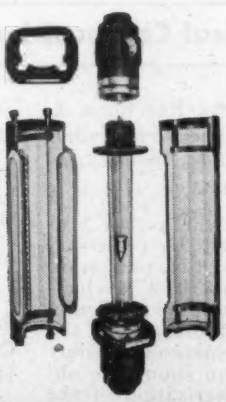
8 MAJOR ROTAMETER IMPROVEMENTS!

- **Totally enclosed safety construction**
- **Great strength and rigidity**
- **Quick assembly or disassembly**
- **Flanged packing glands**
- **Outside packing gland adjustment**
- **Universal piping connections**
- **Safety float stops**
- **Clean, attractive design for panel mounting**

What features do you consider necessary in a rotameter to meet every requirement for accurate flow measurement? In a survey conducted by Fischer & Porter, 250 instrument engineers answered this question with sketches and suggestions. These were carefully analyzed, then combined with features suggested by our field experience, and built into the new Master Enclosed Rotameter.

The Master Enclosed Meter has strong, pressed-steel structural members that enable it to take full line strain and hard usage. Furthermore, the Operator is fully safeguarded because the rotameter tube is completely enclosed and readings are taken through safety glass panels. Universal end fittings permit horizontal pipe connections at any angle. Stuffing boxes are easily adjusted from the outside and for cleaning purposes the meter comes apart readily by removing a few screws.

The Master Enclosed Rotameter is available in all forms—indicating, recording or recording-controlling in sizes up to 4″ inclusive for handling a maximum of 300 GPM of water or 400 CFM of air. Catalog 25-D gives the complete details. Obtain a free copy by writing to us on your Company letterhead.



Completely disassembled Master Enclosed Rotameter, showing simplicity of construction and ease of handling.

The stuffing boxes of the Master Enclosed Meter may be adjusted *from the outside* of the meter.

FISCHER & PORTER CO. 1912 COUNTY LINE RD. HATBORO, PENNA.

SCIENCE AND TECHNOLOGY ABSTRACTS

prepared in cooperation with

PETROLEUM REFINER

by

THE LESLIE LABORATORIES

Traver Road, Ann Arbor, Michigan
under supervision of

DR. E. H. LESLIE and DR. H. B. COATS

The abstracts here presented are selected from the current literature of science and technology to afford reference to fundamental information not easily available to all readers. Abstracts of articles appearing in readily obtainable trade journals are not included.

Photostat copies of original articles will be supplied at cost by The Leslie Laboratories. Complete or limited bibliographies covering special topics by title, by abstracts, or in complete manuscript, will also be prepared and furnished at reasonable cost by the Laboratories.

Fundamental Physical and Chemical Data

Volume Correction Factors for C_4 Hydrocarbon Mixtures. C. S. CRAGOE. National Bureau of Standards Letter Circular LC-757. *Ind. & Eng. Chem., Anal Ed.* **16** (1944) p. 602.

The circular presents 23 pages of volume correction factors for C_4 hydrocarbon mixtures. These data were compiled at the request of the Rubber Reserve Company to supplement tables on pure hydrocarbons and to make available standard tables especially applicable to C_4 mixtures of a wide range of composition. The tables report a means for correcting volumes observed at various temperatures to the conventional standard units at 60° F. Copies of the document are available on request from the National Bureau of Standards in Washington.

Phase Equilibria in Hydrocarbon Systems. H. H. REAMER, R. H. OLDS, B. H. SAGE, AND W. N. LACEY. *Ind. & Eng. Chem.* **36** (1944) pp. 956-8.

Few investigations of the volumetric properties of ethane have been made at pressures and temperatures above the critical state values. In the course of studying the properties of ethane in binary mixtures of industrial importance it was deemed advisable to reinvestigate the volumetric behavior of ethane over a wider range of pressure and temperature. Accordingly the volumetric behavior of ethane was investigated at pressures up to 10,000 pounds per square inch in the temperature interval between 100° and 460° F. The results of the experimental work are presented in tabular and graphical form. Comparisons are made with values obtained by others in recent investigations and with extrapolations based on Beattie-Bridgeman equations of state. A bibliography of 7 references is appended.

Thermodynamic Properties of cis-2-Butene from 15° to 1500° K. R. B. SCOTT, W. J. FERGUSON AND F. G. BRICKWEDDE. Res. Paper RP 1592, *J. Res. Natl. Bur. Standards* **33** (1944) pp. 1-20.

The specific heat of solid and liquid cis-2-butene is reported from 15° to 300° K. The heat of vaporization is given at several temperatures between 246° and 293° K., and the vapor pressure from 200° to 296° K. The heat of fusion at the triple-point is given. Using the experimental data, calculations were made to determine the normal boiling point, the volume of the saturated vapor, enthalpy and entropy of the solid and the liquid from 0° to 300° K., and entropy, enthalpy, and specific heat of the vapor in the ideal gas state from 245° to 300° K. Thermodynamic functions for cis-2-butene in the ideal gas were made from the range 300° to 1500° K. using spectroscopic data.

Solubilities of Some Normal Saturated Aliphatic Hydrocarbons. A. W. RALSTON, C. W. HOERR AND L. T. CREVIS. *J. Org. Chem.* **9** (1944) pp. 319-28.

The solubility of normal octane, dodecane, hexadecane, heptadecane and dotriacontane in benzene, cyclohexane, tetrachloromethane and trichloromethane was investigated. The solubility of the normal aliphatic hydrocarbons depends upon the polarity of the solvent, and when this is higher than that of acetone the solubility decreases rapidly. The aliphatic hydrocarbons are almost immiscible with such strongly polar substances as methanol, ethanol, nitroethane and acetonitrile. The solubility of the hydrocarbons named decreases as the dielectric constant increases. The hydrocarbons are somewhat more soluble in isopropanol and in n-butanol than would be expected from their dielectric constants. The solubilities of the hydrocarbons at different temperatures are shown in tabular and graphical form.

Heating Value of Natural Gas. A. J. W. HEADLEE AND J. L. HALL. *Ind. & Eng. Chem.* **36** (1944) pp. 953-55.

The heats of combustion of several thousand samples of natural gas have been determined in the laboratory of the West Virginia Geological Survey during the past eight years. The data are of value in the operation of a water-flow gas calorimeter. The total and net heating values of natural gas are related by the empirical equation: $THV - 1.072\ NHV = 34 - 0.34\ I$. This equation is used to check the accuracy of the corrections for the water of combustion of a water-flow gas calorimeter. The net heating value can be calculated from the total heating value by this expression, and vice versa. The suggested calorimeter practice will shorten the number of man-hours per test, increase the accuracy and decrease the size of the test sample.

Nomogram to Convert Weight and Mole Percentages in Binary Systems. R. F. BENENATI AND J. G. HARRISON, JR. *Ind. & Eng. Chem.* **36** (1944) pp. 934-5.

Analytical results are almost always expressed as weight percentage, but the physical chemist, the engineer, or the operator in synthesis usually works with mole fraction or mole percent. The author presents a nomogram that involves no calculation and furnishes a direct solution for mole percent when composition by weight and molecular weight of two components are known. The solution is also possible for weight percent when the mole percent is known.

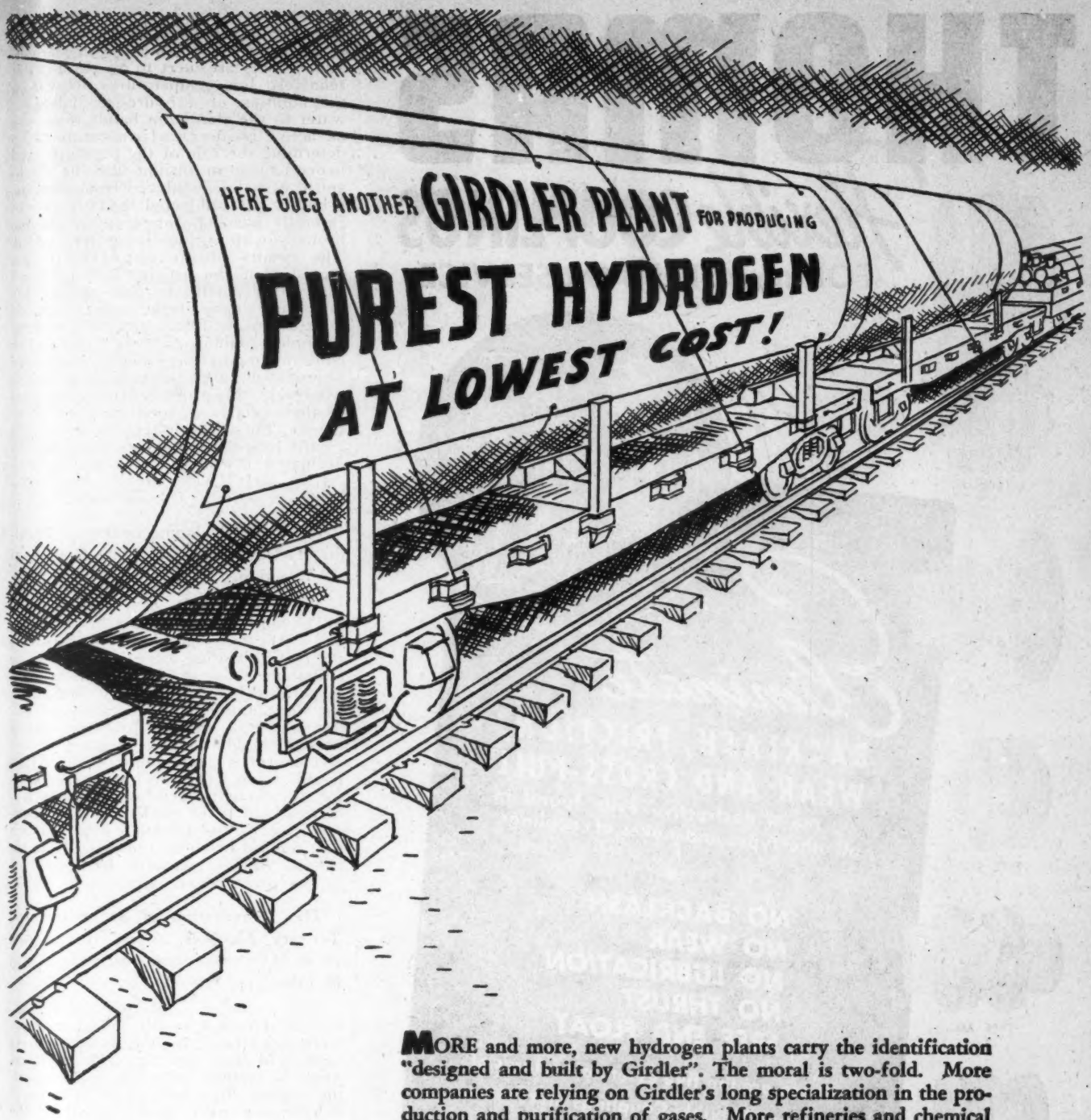
Chemical Compositions and Reactions

Aliphatic Friedel-Crafts Reactions. I. The Alkylation of Butanes by Methyl and Ethyl Bromide. J. D. HELDMAN. *Jour. Amer. Chem. Soc.* **66** (1944) pp. 1791-3.

In a preceding paper the author presented a mechanism for the promoted aluminum halide catalyzed isomerization of paraffin hydrocarbons. The mechanism proposed leads to the prediction that under certain conditions, when the promoter is methyl bromide or possibly ethyl bromide, alkylation should be observed along with isomerization of the paraffin, when the paraffin is of low molecular weight such as butane. In short, a purely aliphatic Friedel-Crafts alkylation should occur. The experiments reported in the present article were conceived and carried out as a test of this proposed mechanism. The experimental work is described in some detail. It was found that in the presence of aluminum bromide methyl- and ethyl-bromide will alkylate butanes to give substantial yields of pentanes and hexanes, respectively, as well as of some higher paraffins.

The Catalytic Isomerization of Paraffin Hydrocarbons. II. Promoters for Catalysis by Aluminum Bromide. J. D. HELDMAN. *Jour. Amer. Chem. Soc.* **66** (1944) pp. 1786-88.

Although aluminum halides, as ordinarily prepared and handled, are catalysts for the isomerization of paraffin hydrocarbons, it has been shown that the pure bromide, in the absence of



MORE and more, new hydrogen plants carry the identification "designed and built by Girdler". The moral is two-fold. More companies are relying on Girdler's long specialization in the production and purification of gases. More refineries and chemical processors are finding that Girdler engineered plants make it profitable to produce their own hydrogen. *Consider these points in the light of your own needs:* Girdler has supplied plants with capacities up to several million cubic feet per day. These plants produce hydrogen continuously at lowest possible cost. They obtain any desired degree of purity. They operate efficiently at 20% to 100% of rated capacities. Carbon dioxide is a usable, salable by-product. • *Now is a wise time to let us study and make recommendations for your requirements.*

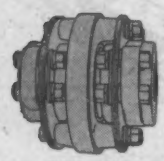
Girdler offers other processes for gas manufacture, purification, separation and dehydration . . . Consult us on your problems concerning hydrogen sulphide, carbon dioxide, carbon monoxide, natural gas, refinery gases, liquid hydrogen, nitrogen.

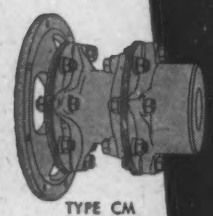
The GIRDLER CORPORATION
Gas Processes Division · Louisville 1, Ky.

CHEMICAL ENGINEERS AND CONSTRUCTORS

THOMAS
Flexible COUPLINGS
FOR *any* SPEED OR SERVICE

TYPE DBZ


TYPE DSM

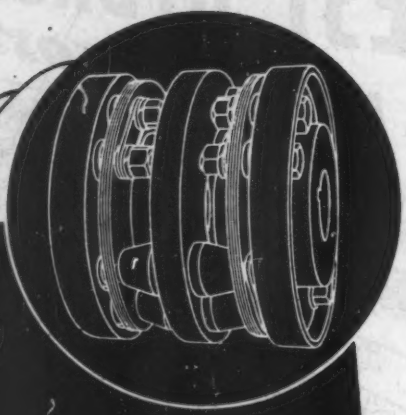

TYPE CM

TYPE ST

TYPE AM

TYPE MT

TYPE SS



Eliminate

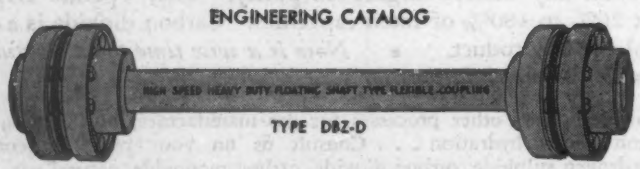
BACKLASH, FRICTION, WEAR AND CROSS-PULL

.....the 4 destructive evils found in all other types and makes of couplings.

NO BACKLASH
NO WEAR
NO LUBRICATION
NO THRUST
FREE END FLOAT

These are the five essential features of Thomas Flexible Couplings that insure a permanent care-free installation.

WRITE FOR COMPLETE ENGINEERING CATALOG


TYPE DBZ-D

THE THOMAS PRINCIPLE ELIMINATES CHAINS, SPUR GEARS and other VIBRATING MAKESHIFTS

THOMAS FLEXIBLE COUPLING CO.
WARREN, PENNSYLVANIA

moisture, has no effect as a catalyst and is therefore presumably the dry aluminum halides are inert to all paraffins at relatively low temperatures. However, the addition of a hydrogen halide or water to the aluminum halide results in an active isomerization catalyst. To determine the role of the promoter and hence to gain an insight into the mechanism of halide-catalyzed isomerization, n-butane was subjected to the action of carefully purified, anhydrous aluminum bromide with various promoters added. The results of the experiment are recorded in the article. It was found that under conditions that obviate the possibility of the presence of extraneous moisture or hydrogen bromide, sodium bromide, sodium chloride, hydrogen chloride, methyl bromide, methylene bromide, n-butyl bromide, and boron trifluoride all promote the aluminum bromide-catalyzed isomerization of n-butane. These results can be correlated by the hypothesis that tetrahedrally coordinated aluminum groups such as ALX_4^- and $HA1X_4$ are the true catalysts for paraffin isomerization.

The Catalytic Isomerization of Paraffin Hydrocarbons. III. The Course of the Reaction. J. D. HELDMAN. *Jour. Amer. Chem. Soc.* **66** (1944) pp. 1789-91.

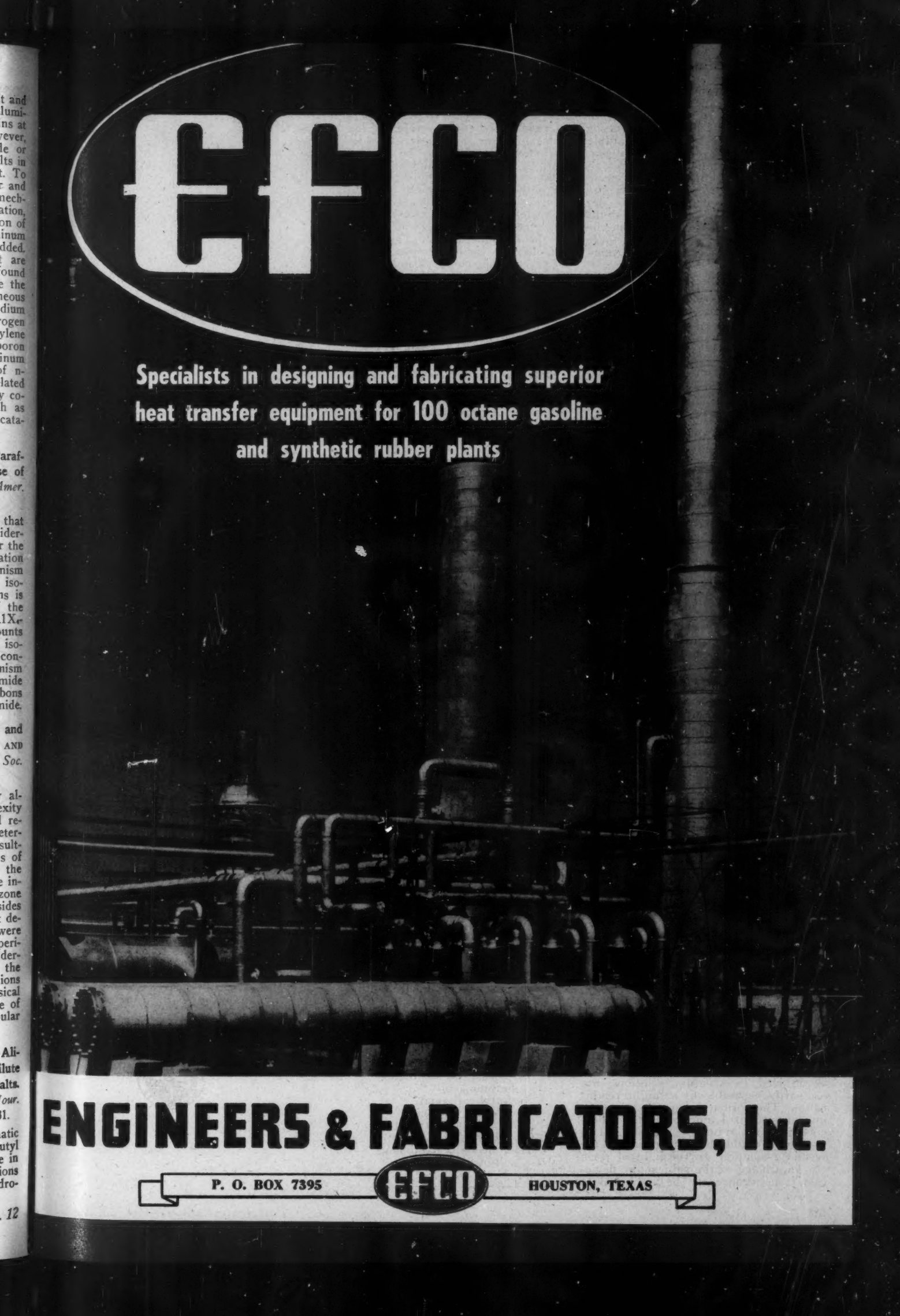
The author first reviews the facts that are at the disposal of anyone considering or formulating a mechanism for the aluminum halide catalyzed isomerization of paraffin hydrocarbons. A mechanism for the aluminum halide catalyzed isomerization of paraffin hydrocarbons is presented. The striking feature of the mechanism is that aluminum in $A1X_6$ is still acidic. The mechanism accounts for the known facts of paraffin isomerization. It is predicted as a consequence of the postulated mechanism that methyl bromide and ethyl bromide should alkylate paraffin hydrocarbons in the presence of aluminum bromide.

The Dehydration of Secondary and Tertiary Alcohols. A. L. HENNE AND A. H. MATUSZAK. *Jour. Amer. Chem. Soc.* **66** (1944) pp. 1649-52.

Ten secondary and two tertiary alcohols of varied length and complexity were dehydrated by means of acid reagents, in order quantitatively to determine the identity and ratio of the resulting olefins. Standardized procedures of dehydration were used and all of the olefins formed were isolated as pure individuals, and then oxidized with ozone to demonstrate their structure. Besides the products expected from straight dehydration, rearranged derivatives were also found. The results of the experimental work are presented in considerable detail in a tabulation showing the alcohols used, the reaction conditions of the products obtained. The physical properties of the alcohols and some of the olefins are presented in tabular form.

The Dehydration of the Lower Aliphatic Alcohols in the Presence of Dilute Aqueous Solutions of Acids and Salts. V. N. IPATIEFF AND G. S. MONROE. *Jour. Amer. Chem. Soc.* **66** (1944) pp. 1627-31.

The dehydration of the lower aliphatic alcohols including methyl through butyl alcohols was studied under pressure in the presence of dilute aqueous solutions of acids and salts. Anhydrous hydro-


EFCO
Specialists in designing and fabricating superior heat transfer equipment for 100 octane gasoline and synthetic rubber plants
ENGINEERS & FABRICATORS, INC.
P. O. BOX 7395
EFCO
HOUSTON, TEXAS

chloric acid or water alone did not catalyze the dehydration reaction. Dilute aqueous solutions of strong acids in concentrations up to about 5 percent, or salts that hydrolyze to give comparable pH values, catalyzed the dehydration of isopropyl and the butyl alcohols to olefins. Aqueous solutions of weak acids were only feebly catalytic. When the pH range of the solution was 5-7, dehydration proceeded with only slight polymerization of the olefin. When the pH was in the range 3-5 or below there was a tendency for the olefins formed to polymerize to a substantial extent. Methyl, ethyl and n-propyl alcohols were dehydrated to the corresponding ethers with little or no olefin formation. The experimental procedure is described and the experimental results are presented in some detail in tabular and graphical form.

The Polymerization of Cyclohexene with Hydrogen Fluoride. S. M. McElvain and J. W. Langston. *Jour. Amer. Chem. Soc.* **66** (1944) pp. 1759-64.

In connection with a study of the action of hydrogen fluoride on various classes of organic compounds, an investigation of the products formed from the polymerization of cyclohexene was undertaken. Cyclohexene adds hydrogen fluoride at or below room temperature to yield cyclohexyl fluoride. In the absence of free hydrogen fluoride the cyclohexyl fluoride may be isolated. At 100° C. cyclohexene and an equivalent of hydrogen fluoride or cyclohexyl fluoride with catalytic amounts of hydrogen fluoride are converted into polymers of cyclohexene. Fluorohydrocarbons appear to be intermediates in the course of this polymerization. The dimer of cyclohexene, which consists of about 80 percent bicyclohexyl and 20 percent of cyclohexyl-Δ1-cyclohexene, is readily dehydrogenated to biphenyl. Among the trimers of cyclohexene are products that yield m- and p-terphenyl on dehydrogenation. From the tetramer fraction a small quantity of a solid tetramer, $C_{24}H_{38}$, that melts at 269-271° C., was isolated. This tetramer was dehydrogenated with difficulty to a mixture of at least two compounds that approximate the formula $C_{24}H_{18}$ but their properties do not correspond with any known compounds of this formula. Fractions that contain pentamers, hexamers, and heptamers were separated from the polymerization mixture. The experimental work is presented in some detail.

Manufacture: Processes and Plant

Heat Transfer Equipment. P. W. Blaylock. *Amer. Inst. Chem. Engrs* **40** (1944) pp. 593-610.

The author notes that in spite of the adequate treatment of the theory of heat transfer there are few convenient references to the problems involved in the mechanical design and fabrication of this type of equipment. Accordingly he presents a brief discussion of the constructional details of some typical units. Typical designs of condensers, heat exchangers, and reboilers are pictured. A table of references is given to code design formulae for heat exchanger parts. A table is presented giving references to material specifications for heat exchanger parts. The first table presents typical properties and tolerances of commercially available heat exchanger tubing. Tubing is discussed, as well as the design of tube sheets and the expansion of tubes into tube sheets. The design of heads, shell and expansion joint of heat transfer equipment is considered. Typical designs are illustrated. The design of baffles is discussed, as well as bolting and gaskets. A bibliography of 24 references is included.

Azeotropic Distillation. R. H. Ewell, J. M. Harrison and L. Berg. *Ind. & Eng. Chem.* **36** (1944) pp. 871-75.

"Azeotropic" is the term applied to distillations or rectifications which involve the formation of constant-boiling mixtures. These are of importance in that they occur in many systems to be separated by fractionation and that the procedure of azeotropic distillation can be utilized to separate solutions not ordinarily separable by straight rectification. The formation of constant-boiling mixtures is a function of the difference in temperature between the two components and the nonideality of the resulting solution. In the light of present knowledge of the subject the deviation from ideality can be attributed to the effect of hydrogen bonds or internal pressure. However, the former is the more important. The concept of hydrogen bonds is that hydrogen can coordinate between two molecules of oxygen, nitrogen, or fluorine. It can also coordinate between one of these donor atoms and a carbon atom, provided a sufficient number of negative atoms or groups are attached to the carbon atom. Hydrogen cannot coordinate between two carbon atoms. The strength of hydrogen bonds depends upon the nature of the atoms between which the hydro-

Chemicals Wanted

The National Registry of Rare Chemicals, Armour Research Foundation, Thirty-third, Federal and Dearborn Streets, Chicago 16, Illinois, has received urgent requests for the chemicals listed below. If anyone has one or more, even if only in one gram quantities, please inform the registry.

Bismuth trifluoride
Ammonium fluosilicate
Benzotrifluoride
Phenyl carbamate
1-Allyl piperidine
o-Amino benzaldehyde
1,2,3,5-Tetrahydroxy benzene
2-Benzene azo alpha naphthol
1-Benzyl piperidine
1-Benzyl morpholine
2-Chloro mandelic acid
2-Chloro fluorene
Distearyl sulfone
Diallyl maleate or fumarate
2,3-Dihydroxy napthalene-6-sulfonic acid
Isobutyl carbamate
Methyl nitrolic acid
1-Nitro butane or pentane
Pyrazole
Sodium alpha napthalene sulfonchloroamide

Vapor recovery and fractionating plant in an East Coast refinery, designed and constructed by Petroleum Engineering, Inc. Offices: Tulsa and Houston.

Photographed for Petroleum Engineering, Inc.
By Robert Yarnall Richie

Trouble-shooting made easy when the new Wilson Check List is used. Available for the asking, this new bulletin contains information of value to the user of tube cleaners.

Among the valuable tube cleaning aids in the Check List are:

1. **A tube cleaner's check list—questions to ask yourself both before and after tube cleaning as well as while on the job—all help you reduce operating and maintenance expense and increase tube cleaning efficiency.**
2. **Tube cleaner selection guide—helps the engineer select the proper tube cleaning motor and cutter head for his particular fouled tube problems.**
3. **Table of tube cleaner sizes—helps you get prompt action on new and replacement orders for your Wilson Tube Cleaners.**
4. **A complete list of Thomas C. Wilson's representatives in all principal cities of the United States and Canada—to help you get better tube cleaner service, newest educational literature, etc.**

MODERN TUBE-CLEANERS FOR THE PROBLEMS OF TODAY

wilson

THOMAS C. WILSON Inc.
21-11 44th AVENUE, LONG ISLAND CITY 1, NEW YORK

gen is coordinating. Based on hydrogen bonds, it is possible to arrange organic liquids into five classifications. It is then possible to generalize regarding binary systems composed of combinations of these classes. Thus, by assigning two liquids to their proper hydrogen bond classes, the nature of the deviations from ideality and the likelihood of azeotrope formation can be predicted. Classification of liquids into five classes is given and the different classes are discussed. Entrainers are considered. The purpose of an entrainer is either to separate one component of a closely boiling pair or to separate one component of an azeotrope. The general methods for using entrainers are summarized. Separation of hydrocarbons is discussed. The proximity of the boiling points of the entrainer and the hydrocarbons is important in selecting an entrainer for the separation of hydrocarbons. An entrainer for separating hydrocarbons should boil within a limited range (0-30° C.) of the hydrocarbon that it is desired to separate. The entrainer should form, on mixing with the hydrocarbon, a large positive deviation from Raoult's law, to give a minimum azeotrope with one or more of the hydrocarbon types in the mixture. It should be soluble in the hydrocarbon at the distillation temperature and for some degrees below it. It should be easily separated from the hydrocarbons with which it forms an azeotrope, and should be nonreactive with them. A bibliography of 14 references is given.

Ternary Liquid Equilibria Predicted from Binary Vapor-Liquid Data. ROBERT E. TREYBAL. *Ind. & Eng. Chem.* **36** (1944) pp. 875-81.

The increasing use of the unit operation liquid-liquid extraction as a means of separating the components of a binary solution has made it necessary to have at hand for design purposes many solubility data for ternary liquid systems. In the absence of such data, it will frequently be desirable to predict from the properties of the components of a system whether a certain solvent will be useful in liquid-liquid extraction processes. In this manner it may prove to be unnecessary to go through the tedious laboratory work involved in determining the complete phase diagram. Any method of prediction of this sort must be based on properties that are readily available. The graphical method proposed by Hildebrand for predicting ternary liquid equilibria from activity coefficients of binary solutions has been applied by the author to a number of systems, using constant pressure and constant temperature vapor-liquid equilibrium data and azeotropic measurements. No data on the ternary system are necessary for its application. The results at low concentration compare favorably with the observed data, and prove the method to be reliable in predicting which solvent will be useful in solvent extraction processes. The use of the van Laar equations for extending the applicability of the method is discussed. Two modifications to allow for mutual solubility of the contacted solvents are tested; these frequently reproduce the distribution curve at high concentrations more accurately and thus make it possible to estimate roughly the position of the plait point. A simple analytical method of calculating an index of the usefulness of a proposed

HEAVY PRODUCTION OF LIGHT HYDROCARBONS

The experience of our personnel spans the time from the days when efficiency of recovery of liquid hydrocarbons from gas was measured only in terms of charcoal adsorption, to these days when the refining, the synthetic rubber, and the chemical industries are looking to the gasoline plant and cycling plant owner for pure liquid ethane, propane, butanes, pentanes and hexanes.

Hudson designed and constructed the first cycling plant to recover on test runs over 80% of the butanes in the raw gas feed, and other Hudson designed and built plants are in successful operation, recovering high percentages of ethanes and propanes, and closely fractionating the recovered liquid into pure hydrocarbons.

☆ ☆ ☆ ☆

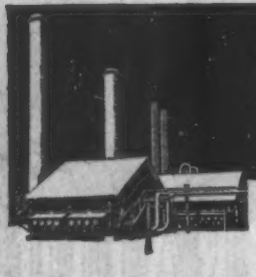
REFINERY PROCESS PLANTS • GAS COMPRESSOR STATIONS • GAS LINE ABSORPTION PLANTS • DISTILLATE RECOVERY PLANTS • FRACTIONATION UNITS • DEHYDRATION PLANTS • NATURAL GASOLINE PLANTS • DESULPHURIZATION PLANTS • HELIUM RECOVERY PLANTS • COOLING TOWERS

HUDSON ENGINEERING CORPORATION

Engineers and Constructors

FAIRVIEW STATION • HOUSTON, TEXAS

For ages the most important use of fire domestically, aside from heat, has been curing food. Industrially, fire has been the vital factor in securing the hundreds of products produced from petroleum. Skilfully combining research and engineering, Alcorn has met the ever changing techniques for heating hydrocarbons. Alcorn installations in major refineries throughout the world have set new standards for low cost operation and high production efficiency. Why not consider the merits of Alcorn's 20 years' experience for the solution of your heating problems?



ALCORN
Combustion Company

SCHAFF BUILDING, PHILADELPHIA
Los Angeles • Houston • San Francisco

solvent in extraction processes for which no ternary data are available is described. The distribution coefficient of Hand is shown to be predictable in certain cases. A modification of his empirical method of plotting distribution data is presented which makes it possible, in the case of some systems, to determine accurately the distribution curve with one measured tie line. A bibliography of 25 references is included.

Catalytic Removal of Sulfur from Liquid Fuel. *Uspekki Khimii* **12** (1943) p. 9. Abs., Petroleum (London) **7** (1944) p. 125.

Hydrogenation over chromia or molybdena at 570-750° F. and 20-50 atmospheres pressure converts sulfur in the oil into hydrogen sulfide, but the costs of such treatment renders the method uneconomic. Zinc oxide at 660° F. reacts with mercaptans and thioethers but not with thiophene, forming zinc sulfide at ordinary pressure and without hydrogen. Zinc sulfide can be converted to oxide by heating in air. Phosphoric acid absorbed on coke reduced the sulfur content of gasoline from 0.47 to 0.10 percent when the gasoline was passed over the coke at 392-410° F. However, it had no value in removing thiophene. Bauxite was more effective when one or two volumes of gasoline were passed through one volume of the mineral. Bauxites containing iron oxides combine chemically even with thiophene derivatives. This renders them less efficient as catalysts but their efficiency can be restored by heating in the presence of hot air or steam. Known sulfur compounds were added to gasoline and the gasoline passed at a rate of 0.45-0.65 volumes per hour through one volume of bauxite containing iron. The results were as shown in the following tabulation:

Sulphur Compound to be removed	°F	Percent S before	Percent S after
Gasoline and thiophene	104	0.265	0.092
Gasoline and isobutyl sulfide	104	0.225	0.029
Gasoline and isobutyl mercaptan	104	0.279	0.044
Cracked Gasoline	104	0.350	0.120

Structure as a Variable in the Application of Diffusion Theory to Extraction. J. O. Osburn and D. L. Katz. *Amer. Inst. Chem. Engrs.* **40** (1944) pp. 511-31.

The application of diffusion theory to solvent extraction from a porous solid has been expanded to include the structure of the solid. It is shown that different structures can produce wide variations in the type of theoretical extraction curve. The comparison of extraction data for different materials can be made only when details of structure of the solid are compared. Extraction curves for the extraction of a material such as soybean flakes are similar to theoretical curves for extraction with two different diffusion coefficients. A method is given for finding the two coefficients from the extraction curve. The literature of the subject is briefly reviewed.

Continuous Lithium and Aluminum Stearate Grease Manufacture. H. G. Houlton, B. D. Miller, P. A. Lenton, J. A. Taylor and B. E. Adams. *Oil and Soap* **21** (1944) pp. 258-63.

In making lithium grease light oil of about 300° F. flash point is used. The

Long run proves plant

THE world's smallest commercial fluid catalyst cracking unit has made good in its initial run on synthetic catalyst, which went 65 days without a stop

It is a part of the Frontier Refining Company's new aviation gasoline refinery in Cheyenne, Wyoming

During the run the plant produced its quota of aviation gasoline, fully meeting the rigid specifications of the Army and Navy

The starting date was May 30 On August 3 the plant was shut down for inspection It was in good condition and could have run longer This unit is now on its second successful run

Universal designed the facilities in the Frontier refinery, which is one of the scores of U. O. P.-designed war plants that are contributing substantially to the aviation gasoline supply—or are nearing completion

CATALYTIC CRACKING	HYDROFORMING
CATALYTIC REFORMING	DEHYDROGENATION
HYDROGENATION	POLYMERIZATION
ALKYLATION	RETREATING
ISOMERIZATION	POLYTREATING
THERMAL CRACKING	U. O. P. CATALYSTS
THERMAL REFORMING	UNISOL TREATING

U. O. P. INHIBITORS

GASOLINE POWERS THE ATTACK — DON'T WASTE A DROP

Universal Oil Products Co.
Chicago 4, Ill., U. S. A.

UOP

Petroleum Process Pioneers
For All Refiners

The Refiners Institute of Petroleum Technology

Plastics

Made of

LAMINATED PHENOLIC PLASTICS

As the plastic material of these rings is practically self-lubricating, temporary loss of lubricant will not affect the life of the piston rings or the liners.

Grit and scale become embedded in the plastic and do not scrape liner as with metal rings.

●

***SHOCK RESISTANCE . . . RESISTANCE TO ABRASION AND WEAR . . . HIGH STRENGTH WITH LOW WEIGHT* make Phenolic Plastics ideal for:**

• Bushings • Bearings • Electric Insulators • Wearing Rings In Centrifugal Pumps • And Many Other Products

●

ENGINEERS familiar with these excellent properties of Laminated Phenolic Plastics are daily finding more and more advantageous uses for them.

●

LARGEST STOCK of Tubing and most comprehensive stock of Laminated Phenolic Rods and Sheets in the Southwest.

●

Proved by leading companies to give lower service cost per hour

●

QUICK DELIVERY . . . WRITE FOR FOLDER AND PRICES

BAKORING
INCORPORATED
1020 HOUSTON AVENUE
HOUSTON, TEXAS

mixture of oil and soap must be heated to about 400° F. to completely dissolve the soap. A completely enclosed continuous process was used. The types and quantities of oils required, the type of soap, and the mixing needed, as well as temperatures, pressures and blade velocities, were studied. The properties of the greases produced by variation in oil, retention time, soap content, outlet temperature, and worked and unworked penetration are tabulated. Aluminum grease is normally made from a much wider range of oils than lithium grease, although much aluminum grease is made from oil of about 100 SSU at 210° F. The slurry of oil and soap was passed through a deaerating unit, heated to 300-325° F., and cooled to 120° F. in the gelling section of the apparatus, and still further cooled and worked. In general it was found that aluminum greases were more sensitive to variations in operation than lithium grease.

Products: Properties and Utilization

Troubles Caused by Leaded Fuels. A. H. STUART. *Petroleum* (London) **7** (1944) p. 113.

Lead tetraethyl boils at 200° C. and decomposes. One pound of lead is formed for every 120 gallons of gasoline burned. At the temperature of the exhaust valves of an engine the lead is melted but not vaporized. In the main it is converted to litharge, which has a melting point of 888° C. While liquefied during the course of the explosion it solidifies on the cylinder walls, piston heads and even the hottest parts of the exhaust valves. The use of ethylene dichloride or ethylene dibromide does not prevent this deposition; and the deposit not only interferes with the proper treating of the valves but is also corrosive. It is found that a film of graphite from Aquadag when deposited on a steel rod prevents any adhesion of lead when the rod is dipped repeatedly into the molten metal. Plain steel with no graphite film was coated irregularly with lead and adhered tenaciously. Aquadag or a solution prepared from it can be applied to a valve stem and head to give an adherent film that is so greasy that foreign matter will not stick to it. An upper cylinder lubricant can be used along with Oildag. One-half fluid ounce to the gallon is enough for this purpose in a new or reconditioned engine. A 6-ton truck was run 32,000 miles with graphited upper-cylinder lubricant. When it was dismantled the valve seats were in excellent condition. The graphite also protects to some extent against corrosion.

A New Synthetic Detergent from Petroleum. *Chem. & Ind. Editorial. Soc. of Chem. Ind.* **37** (1944) p. 327.

Petroleum is becoming increasingly important as a source of organic compounds some of which have previously been derived from other raw materials, and others that have not been available commercially. Among the more recent and important developments in organic synthetics from petroleum is the production of a new surface active compound that possesses many of the characteristic properties of soap. The Shell Group has engaged in an intensive research in this field and has recently built a large plant in England for the production of the sodium salts of higher secondary alkyl sulphates. The product is marketed under the name of "Teepol." The manufacture of Teepol involves the cracking of the base material to produce a mixture of long chain olefins. This mixture is fractionated and a selected cut corresponding to the C_{10} to C_{18} range is sulfated and neutralized under carefully controlled conditions followed by special extraction and purification methods whereby a product of high purity and efficiency is obtained. Substances of this type usually comprise a long hydrocarbon chain with a polar head, the hydrocarbon chain being olephilic and the polar head hydrophilic. Teepol is unaffected by hard water or by saline solutions and is stable over a wide pH range. The addition of small quantities to aqueous solutions brings about considerable reduction in surface tension and in the interfacial tensions between such solutions and oils. For many purposes in the textile and laundry industries, this product can replace soap completely, and in other instances partial replacement of soap results in increased efficiency. It should have further wide application in electro-deposition, acid pickling, aqueous degreasing, and as an additive to fluxes of the zinc chloride type. It is also used in the manufacture of leather, cosmetics, paper, paints, disinfectants, insecticides, and emulsions, and is of interest in all processes where wetting, penetration and dispersion in aqueous media are involved.

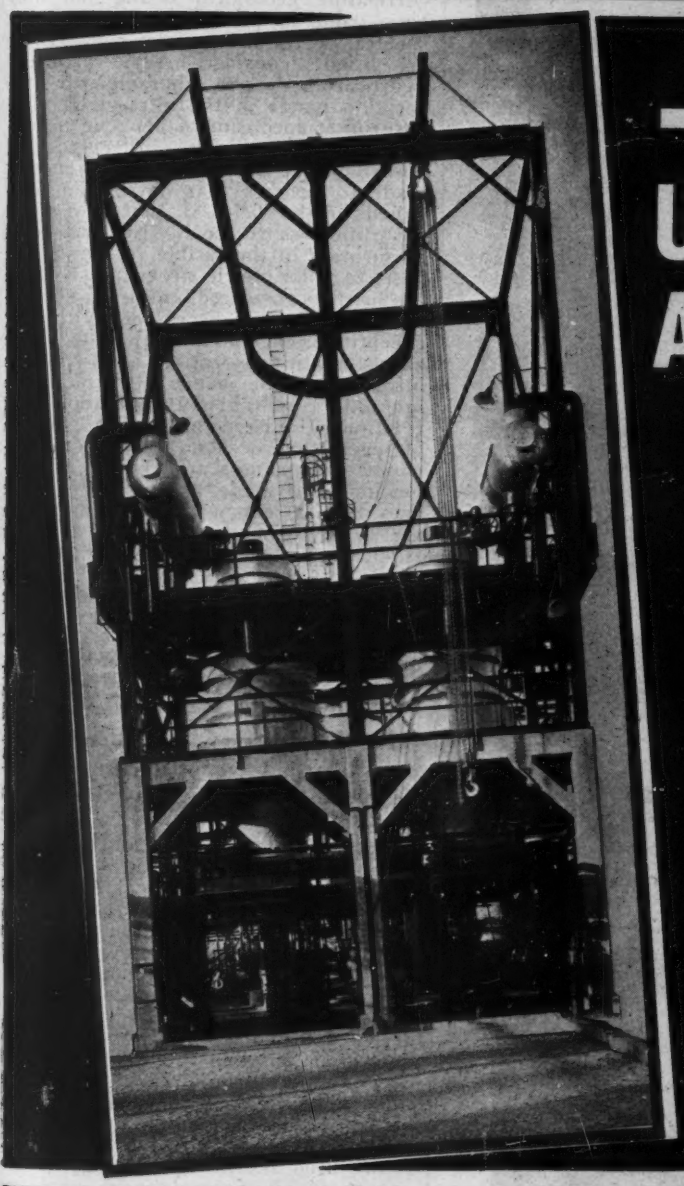
A General Utility Laboratory Distillation Column. W. M. LANGDON AND G. M. O'BRIEN, JR. *Ind. & Eng. Chem., Anal. Ed.* **16** (1944) pp. 639-40.

The authors describe what they believe is a column that embodies most of the characteristics desirable for general utility. It is easily constructed of commonly available materials, and is suitable for most distillation operations. Distillations can be conducted at pressures varying from a few millimeters of mercury absolute to several pounds per square inch gage. The column can also be used for absorption and extraction operations. The construction of the column is described in some detail including the distillation tubes, the still head and the column jacket.

Spectral Methods and Their Application in the Petroleum Industry. W. H. NAYLOR. *Jour. Inst. Petr.* **30** (1944) pp. 256-65.

Many of the modern advances in the physical sciences have had their inception in spectral investigations. It is to be expected that as the petroleum industry turns more and more from a producer of raw materials to a chemical industry, it will increasingly utilize spectral methods of analysis. The author first discusses X-rays, noting that they are produced when an electron fills a vacant space in an inner electronic shell of an atom. Applications of X-rays in industry and in analytical work are briefly described. The suggestion is made that X-rays may prove useful in a study of catalysts in various petroleum refining processes. Ultra-violet and visible radiation is briefly discussed, and uses of the spectrograph described.

More Than 100 STRATCO CONTACTORS



-Serve United Nations Alkylation Plants

Making Possible

HIGHER YIELD HIGHER OCTANE

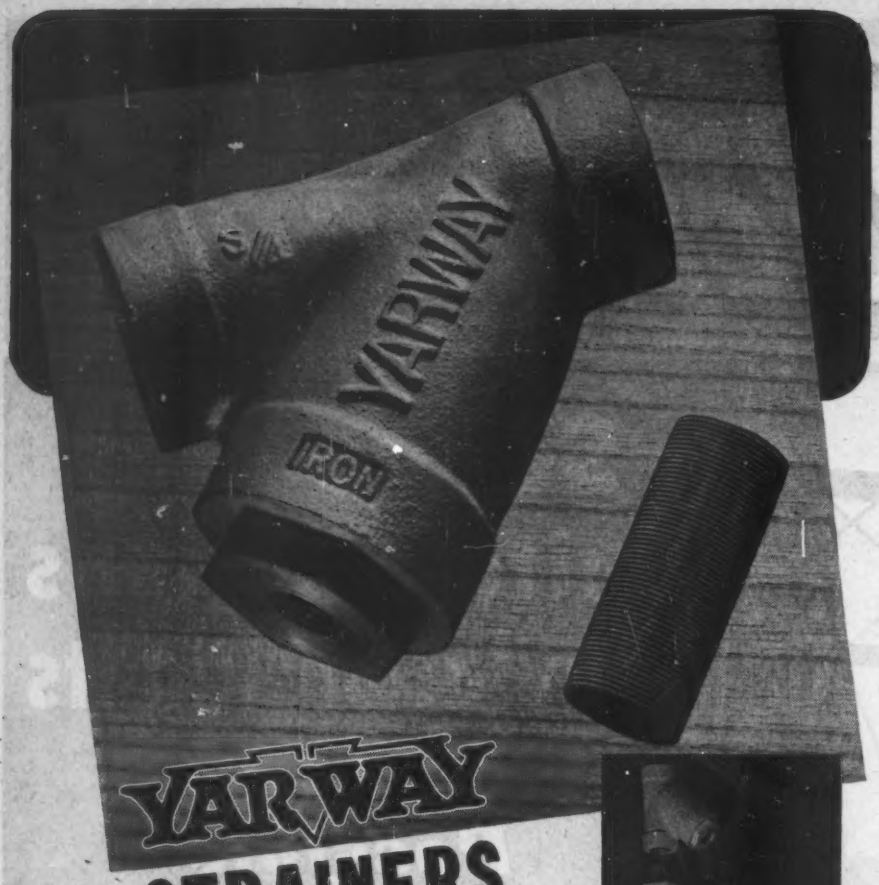
and More Fighting Fuel

STRATFORD ENGINEERING

CORPORATION

PETROLEUM REFINING ENGINEERS

DIERKS BLDG. KANSAS CITY, MO.



YARWAY

STRAINERS

"Police the Pipelines"

YARWAY STRAINERS are *selling by the thousands* because they are better engineered for the service.

"*The Screen is the Thing*"—a high-grade, woven Monel wire screen that stops the dirt, lets fluids flow freely.

Then, too, purchasers like the *body finish—Cadmium plating inside and out* for protection against corrosion.

And last but not least, it is "*Easy to Clean*" having a steel blow-off bushing, precision machined with straight thread. Screen and bushing come out together—go back together, automatically aligning.

Six sizes, ½" to 2" for pressures up to 600 lb serve practically all strainer needs.

Sold by over 100 Mill Supply Houses. See your Supply House or write for Bulletin S-200.

YARNALL-WARING COMPANY
128 Mermaid Avenue PHILADELPHIA 18, PA.

YARWAY STRAINERS

Emission spectra can be used in the petroleum industry in studies of engine-wear, since iron can be detected to 1 part in a million. Inorganic impurities in crude oil can be determined. All parts of metallic equipment, as well as clays, sludges, and catalysts, can be analyzed by this means. Spectrographic analysis is of particular importance in the case of catalysts, since the presence of small quantities of impurities may markedly change the catalyst efficiency. Emission spectra are used by some oil companies for analysis of cores, soil, and water in oil-fields. These spectra are useful in correlating geological strata, and may have value in prospecting. Absorption spectra in the ultra-violet and visible are briefly considered. The aromatic hydrocarbons have characteristic absorption bands in the ultra-violet. The absorption spectrum of benzene is presented. Paraffins and naphthenes do not absorb in the ultra-violet. Reference is made to reviews that have been published in the field of the ultra-violet absorption spectra by hydrocarbons. Absorption in the visible regions is the basis of colorimetric procedures. These are briefly considered. Infra-red absorption spectra are discussed. With few exceptions chemical compounds have characteristic absorption bands in the infra-red. These bands correspond to interatomic vibrations and molecular rotation. Infra-red absorption spectra of several hydrocarbon gases from propane to isopentane are presented. Suggestions are made as to the possible uses of infra-red spectra. Raman spectra are briefly discussed as well as their application for analytical purposes. These spectra have been used for the identification and semi-quantitative analysis of paraffins up to C_8. Mass spectroscopy and its application are briefly discussed in concluding the article. A bibliography of 39 references is appended.

Preliminary List of Definitions. Standardization Subcommittee No. 11—Nomenclature. *Jour. Inst. Petr.* **30** (1944) pp. 266-70.

The Institute of Petroleum at a meeting of its Standardization Committee appointed a sub-committee whose task was the preparation of a glossary of common terms used in the petroleum industry. The definitions were to be couched in as simple language as possible, in order that the non-technical reader could consult the glossary and derive a benefit from it. So far it has only been possible to deal with terms covering petroleum products, which, in the main, are widely distributed. It is hoped, later, to extend the work to embrace refinery nomenclature and terms used in the search for and recovery of oil. Several pages of definitions are given and include such items as B.S.&W., carbon black, diesel fuel, gas oil, paraffine, naphtha, ether, volatility, white spirits, and the like.

McCarthy Building Gas-Stripping Plant on Coast

Glen H. McCarthy, Inc., Houston, has let contract to Stone & Webster Engineering Corporation for construction of an absorption-type gasoline plant to process 45,000,000 cubic feet of gas daily from fields in the Chambers-Jefferson County area, Texas Gulf Coast. Stripped gas will go to the Beaumont-Port Arthur area.

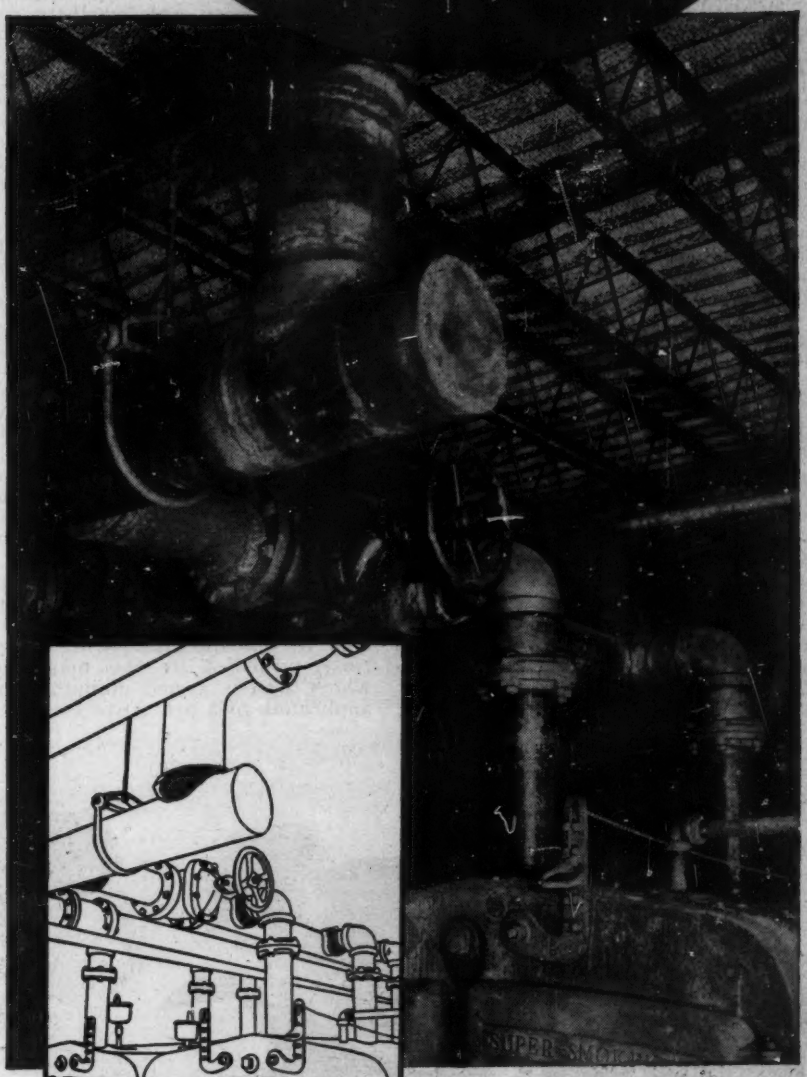
When you need Pipe Outlets -use WeldOlets

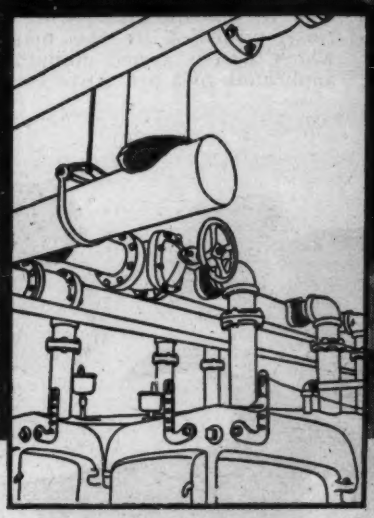
Check these WeldOlet features which insure easy, economical and efficient branch pipe jobs.

1. No need to cut out section of main line. Fitting is used as template, hole cut, fitting tacked and welded to pipe. The inside can then be inspected before branch is connected.

2. Construction of drop-forged WeldOlets restores original strength to main pipe. The heavy reinforcing rib section of fitting compensates for loss of strength in the main pipe when the hole is cut.

3. Free, unrestricted flow is assured because turbulence and friction are reduced to a minimum by the funnel-shaped design of the inlet of the WeldOlet.





WeldOlets are made in size-to-size and reducing sizes for standard pipe sizes up to 24" and for pressures up to 400 lbs. at 750° F.

Our illustrated catalog containing complete application and installation information will be sent to you on request.

ARMY E NAVY

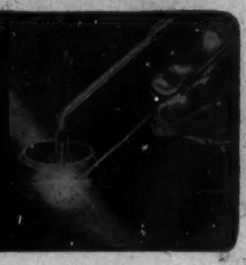
Forged Fittings Division • BONNEY FORGE & TOOL WORKS • *346 Green St., Allentown, Pa.*

WELDOLETS

TRADE MARK REG. U. S. PAT. OFF. PAT. IN U. S. & FOREIGN COUNTRIES

WELDING OUTLET - THREADED OUTLET - SOCKET OUTLET

For Welded Branch Pipe Outlets



NEW Equipment For the Modern Plant

Spectrometer

NORTH AMERICAN PHILIPS COMPANY

North American Philips Company, 100 East 42nd Street, New York 17, has announced a new Geiger-counter X-ray Spectrometer which provides an extremely accurate method for measuring distribution and intensities of X-ray reflections. For certain applications, it has some advantages over conventional refraction procedure which entails exposure and development of film besides measurements and computations. The spectrometer provides a rapid method for directly determining location and intensity of diffracted rays.

A scanning device, having a Geiger counter tube arranged to traverse a graduated quadrant, is used in combination with suitable scaling circuits. The intensity measurements are quantitatively accurate and can therefore be used to determine composition of crystalline mixtures. Quantitative analyses of mixtures can be obtained in a matter of minutes.

In actual operation, the specimen inserted in the specimen holder intercepts the X-ray beam and deflects portions of it at various fixed angles. When the Geiger counter tube is moved around its quadrant, it measures angular displacement and intensity of the deflected beams. A d-c microampere meter reads intensity—the quadrant, marked in degrees, shows diffraction angles. A stepping counter, employed in conjunction with a specially developed scaling circuit, provides a means for exacting quantitative determination of intensity.

X-ray diffraction analysis has almost unlimited fields of application in chemical and metallurgical industry. The Norelco spectrometer is especially designed for accurate, rapid analyses. It is adaptable for use by unskilled operators in routine process control as well as in the research laboratory. To mention just a few applications:

Paint pigments—quickly analyzed for relative amounts of different crystal forms. An analysis of titanium dioxide white pigment for rutile and anatase modifications can be completed in less than ten minutes, specimen time included, with an accuracy of ± one percent.

Boiler scale—only means of identifying many silicate and phosphate scales —determines nature of chemical reactions between scale products.

Engine wear and lubrication—identifies deposits on filters, valves, bearings, etc.

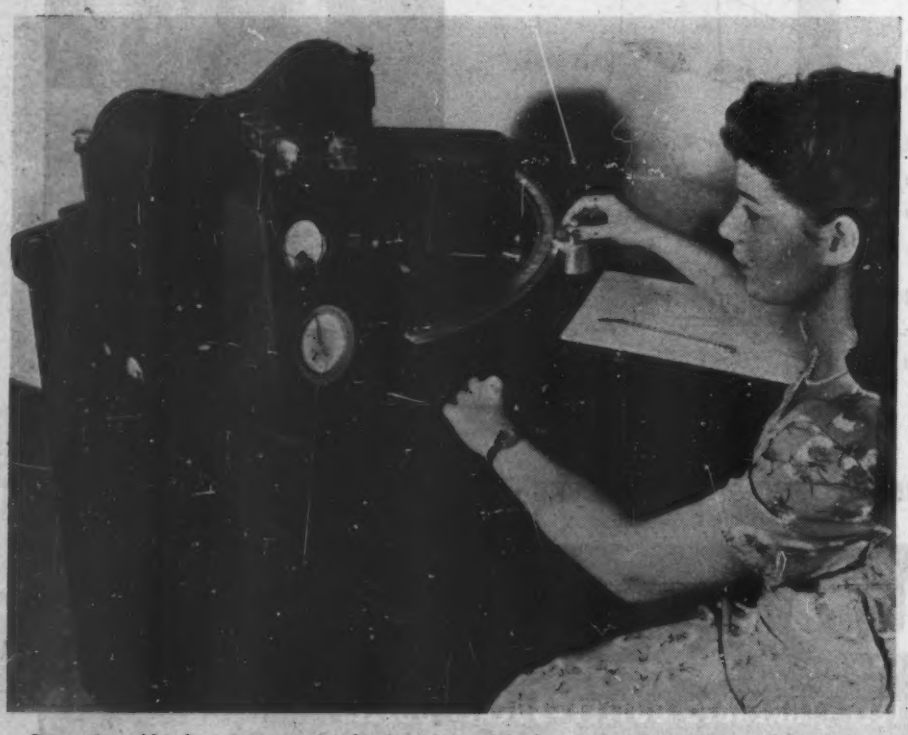
Alloy phase analyses—accurate measurement of retained austenite in steel—alpha and beta phase composition of brass—chemical constitution of the α phase measurable to ± one percent of either copper or zinc.

Power for the spectrometer unit is taken from any convenient 115-volt, 60-cycle a-c outlet.

Rust Solvent

CARBOZITE CORPORATION

Carbozite Corporation, First National Bank Building, Pittsburgh 22, has announced a new solvent for rust which the manufacturer claims has an affinity for rust but will not attack unoxidized metal. "CarboRustex," as the solvent is called, consists of several chemicals, each of which has its reaction upon the various conditions of rusted surfaces. The chemicals are non-toxic and non-inflammable. The compound is applied with spray or brush. Treated surfaces are made chemically clean and vulnerable to oxidation, requiring a special rinse furnished by the manufacturer, which acts as a rust inhibitor pending application of a protective coating.



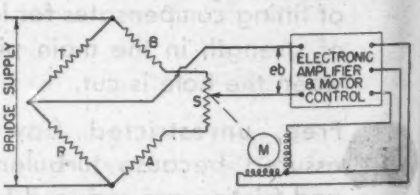
Operator at Norelco spectrometer, showing instruments for measuring intensity and for timing

Electronic Temperature Recorder-Controller

BAILEY METER COMPANY

Bailey Meter Company, 1050 Ivanhoe Road, Cleveland, Ohio, has announced an electronic-type resistance thermometer suitable for indicating, recording and controlling temperatures between —100° F. and 1000° F. This recorder operates on the highly accurate null balance principle and provides instantaneous balancing action by electronic detection and control. Unbalance of the measuring bridge is detected by electronic tubes without the aid of a galvanometer or other moving parts. Reliable performance and accurate calibration over long periods of continuous operation are said to result from this sturdy design.

Electronic temperature recorder-controller



T = TEMPERATURE SENSITIVE PLATINUM RESISTANCE
A, B & R = FIXED RESISTORS M = SLIDEWIRE DRIVE MOTOR
S = SLIDEWIRE

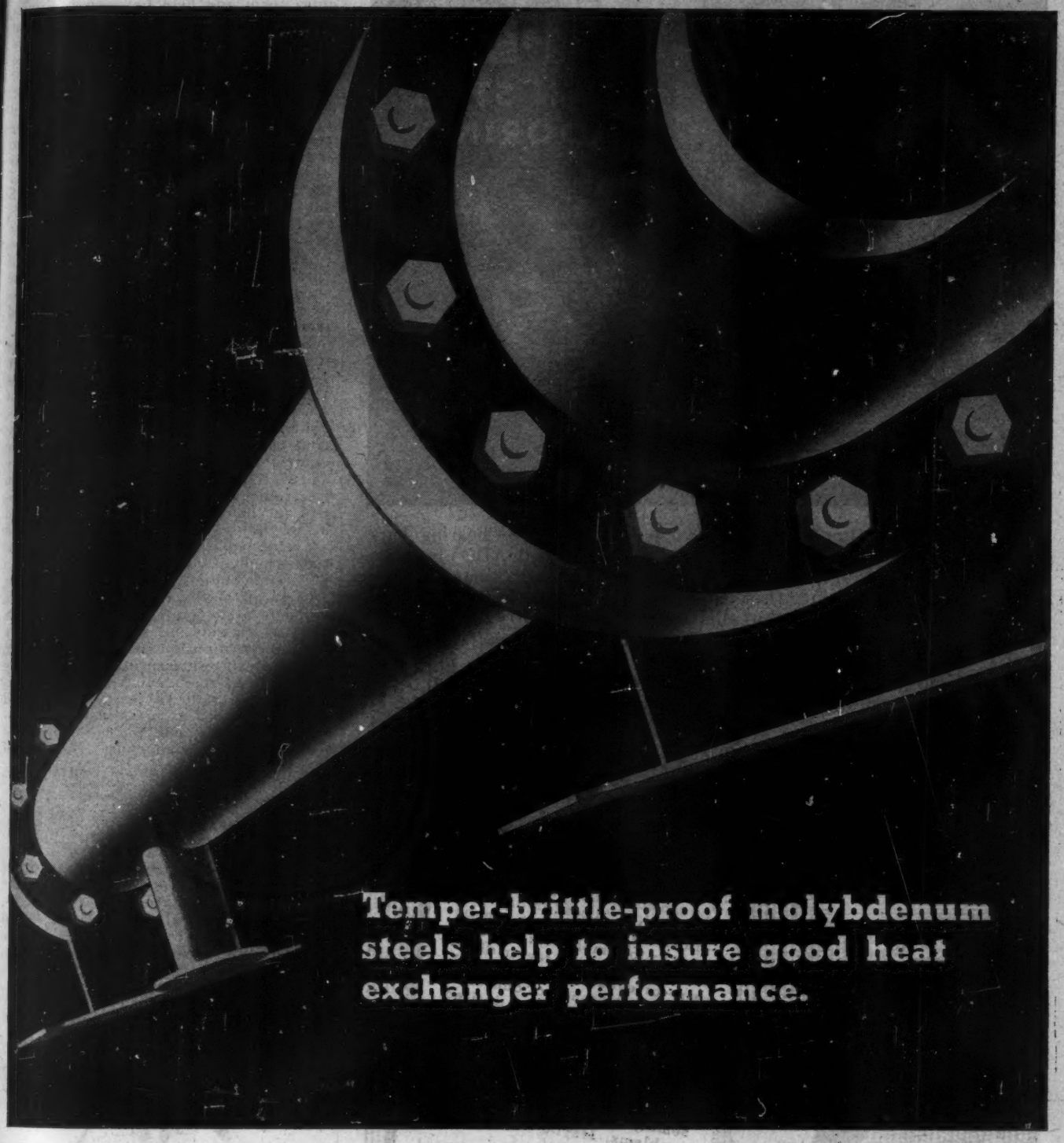
WHEATSTONE BRIDGE MEASURING CIRCUIT

Diagram of the measuring circuit of Bailey electronic temperature recorder-controller

A 29-inch indicating scale which circles the chart may be read at 50 feet. The pointer reading coincides with that of the recordig pen. Indicating, recording and controlling mechanisms are all driven by the same reversible electric motor which adjusts the slidewire resistance to balance the measuring bridge. This motor is continuously connected to the electronic control unit which in turn is continuously connected to the measuring bridge.

Thermometers may be provided with as many as four recording pens, each one being provided with its own continuously connected electronic control unit and measuring bridge. This feature insures instantaneous response to changes in temperature.

The temperature-sensitive element is a platinum resistance wire wound on a



CLIMAX FURNISHES AUTHORITATIVE ENGINEERING DATA ON MOLYBDENUM APPLICATIONS.

ARMY E NAVY

MOLYBDIC OXIDE, BRIQUETTED OR CANNED • FERROMOLYBDENUM • "CALCIUM MOLYBDATE"

Climax Molybdenum Company

500 Fifth Avenue • New York City

MOLY

For strength and simplicity, only two parts are used — bearing bars which carry the load and have curved slots punched ABOVE THE NEUTRAL AXIS, and cross bars, of the same cross sectional area as the slot itself, pressed into these slots to distribute the load. No rivets, bolts or welds are required, thus eliminating the possibility of loose joints. Tri-Lok flooring comes in rectangular, diagonal and U shapes with Safety Steps — ask for Bulletin 1140 — DRAVO CORPORATION, NATIONAL DEPARTMENT, 300 Penn Avenue, Pittsburgh (22), Pa. (Distributor for THE TRI-LOC COMPANY)

DRAVO

"Discs"
LARGE or SMALL
You can now obtain Multi-Metal's high quality "discs" in any size —from the smallest that can be made up to completely fabricated discs or blankets 25 feet in diameter—or even larger if desired. Discs can be made of one or as many layers of cloth as desired and may be made in one piece or many segments. Tell us your "disc" problem. For over 32 years our engineers have helped others solve their Filter Cloth assembly or sheet metal fabrication problems. Maybe we can help you solve yours!

MULTI-METAL
WIRE CLOTH COMPANY
INCORPORATED
1356 GARRISON AVE., BRONX 59, N. Y.
WIRE CLOTH
FILTER CLOTH
ALL MESHES
ALL METALS

mica form and held between two mica sheets which are clamped by a metal frame. The element is further protected by a well which is permanently installed in the pipe line, furnace wall, duct, or other point of temperature measurement. The temperature element is represented in the accompanying diagram by the resistor T. resistors R, A and B are fixed, and are designed to provide proper range of measurement. Adjustment of the slidewire contact on the resistor S substracts resistance from A and adds resistance to B or vice versa. Thus the bridge is balanced by adjusting the ratio of the bridge arms and the necessity of carrying bridge current through the slidewire contact is avoided. Variations in contact resistance thus are prevented from affecting calibration.

Since alternating current is used for the bridge, no battery source of bridge voltage is needed. Standard voltage cells and voltage standardization equipment are not required.

Bailey air-operated control, electronic control or contacts for on-off electric control may be provided for as many as two temperatures by the multiple-pen electronic recorder-controller. The control mechanisms required are mounted inside the recorder-controller casing and are actuated by the same reversible motors which drive the recording pens.

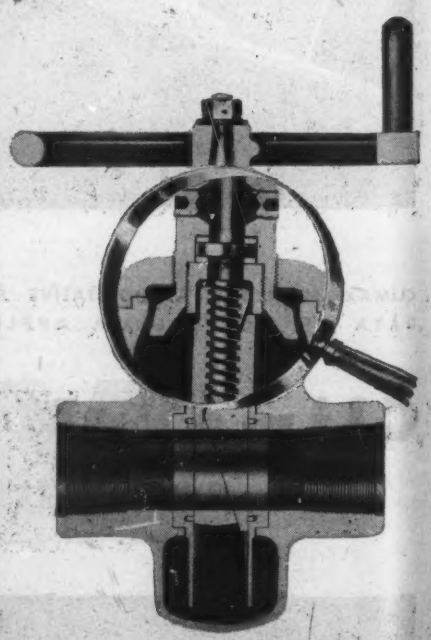
Alarm contacts may be provided for any or all of the recorder units. These contacts are operated by an adjustable cam which may be set to trip at any desired position of the recording pen.

Temperature-measuring circuits may be arranged to calculate the sum, difference and ratio of temperatures, and results recorded as news instead of history, saving the time and labor required for calculation from chart records and log sheets.

Valve

W-K-M COMPANY

W-K-M Company, Houston, has announced a new principle of valve bonnet construction incorporation in a gate valve. The design requires no flanges, no bolts and no gland. Seal is effected inside the body by means of a double tapered ring between similar tapers on



Showing construction of W-K-M steel valve

FOR TUBING TO MATCH EACH CORROSIVE ATTACK

In the wide range of Croloy steel alloys developed by Babcock & Wilcox, there are types that make possible a close match between refinery tubing and the job conditions it must face.

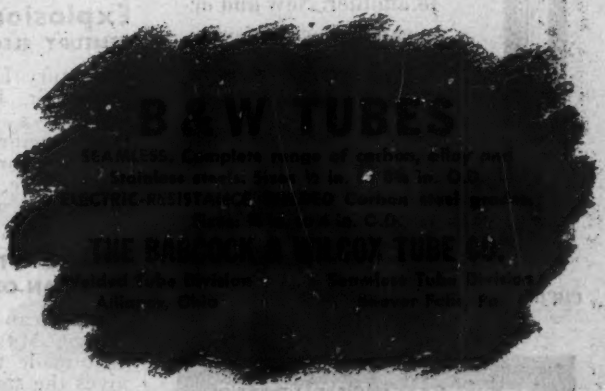
The kind of corrosive attack to be resisted may be one of several types. Its primary cause may be high temperatures, in which case oxidation also must be specially guarded against. It may have its origin in contaminents or corrosive agents in the crude or gases being handled. Conditions encountered in processing may be its source, with the action of catalysts setting up reactions which tend to corrode or carburize tubing.

Among the Croloys listed in the panel and others in ferritic and austenitic stainless alloy steel types—covered by the B&W Croloy stainless steels—there are materials from which the one best tubing may be selected for each of your diverse refinery needs. Data on creep strength, tensile strength, and physical properties are available to complete the background for your decision.

Further help is also at your disposal. Through long associations with many branches of the petroleum industry, B&W engineers are well qualified to recommend the grade of tubing you need. When you call on Croloy, call on their advice and assistance.

CROLOY 1¼	CROLOY 2	CROLOY 2¼
Economic grade good creep strength properties. Somewhat more corrosion resistant than the chromium free steels.	Economic grade for resisting both oxidation and corrosion, with excellent high-temperature strength.	*Exceptionally high creep strength* for polymerization and high pressure cracking. Otherwise similar in properties and characteristics to Croloy 2.
CROLOY 3 M	**CROLOY 5**	**CROLOY 5 Si**
Somewhat better creep properties and better resistance to corrosion and oxidation than Croloy 2.	For operating conditions where corrosion resistance is primary requirement—provides good creep strength and oxidation resistance superior to Croloy 2.	For operating conditions where oxidation resistance is a primary requirement. Excellent resistance to scaling.
CROLOY 5 Ti	**CROLOY 7**	**CROLOY 9**
For oxidation resistance. Non-hardening below 1700° F.	Intermediate steel between Croloys 5 and 9 for operating conditions where corrosion resistance is the primary requirement. Somewhat more oxidation resistant than Croloy 5.	For severe operating conditions where high corrosion and oxidation resistance are essential—suitable for hydrogenation processes.

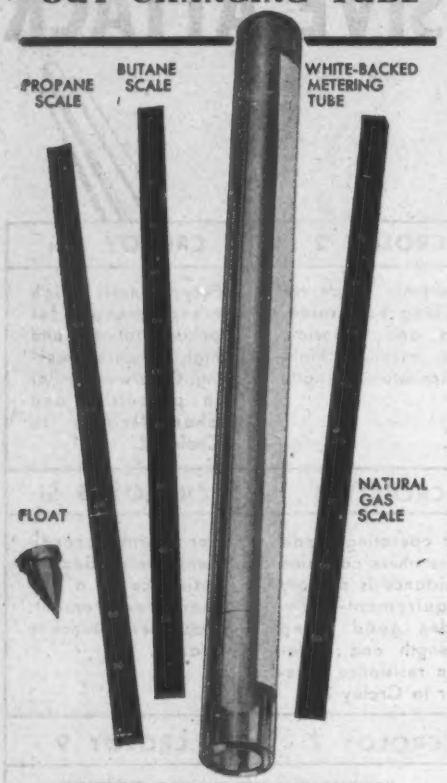
Searching for Better Alloys to Give You Better Tubing



TA-1316

6503

EASY TO CHANGE FROM ONE SERVICE TO ANOTHER WITHOUT CHANGING TUBE



INTERCHANGEABILITY

A Big Feature of Series 100 ROTAMETERS

One important advantage of the Series 100 Rotameters is the interchangeable scales that make it possible to use the same Rotameter when it is desired to change from one service to another. New and accurate scales can be furnished quickly and inexpensively without loss of time and expense in returning meter for recalibration or new tubes and floats.

Write for Publication 4138

COCHRANE CORP., N. 17th St., Phila. 32, Pa.

COCHRANE-ROTAMETERS INC. ROTAMETERS

the upper inside of the body and the lower outer diameter of the bonnet. In assembly the bonnet is inserted in the body, the sealing ring pushed down around the bonnet. When pressure is applied, the ring is wedged in place, forming a positive seal. No residual load is required to maintain a seal. A threaded protector ring or bridge member is screwed on the upper end of the bonnet to complete the assembly. Before application of this ring, the joint may be inspected under full test pressure. Thus internal pressure acts to make the seal more positive. Area of the sealing ring is predetermined and requires no permanent deformation to form a seal. The greater the pressure, the tighter the seal becomes, as it is self-adjusting to pressure and temperature changes. The bonnet and ring are self-aligning. Other features include through conduit, full bore opening through the valve, parallel expanding gate, oversize bronze renewable seats which are not exposed to damage or wear in either open or closed position, and automatic lubrication. The new model is made for 1600- and 1000-pound test pressure.

Plastic Packing

GREENE, TWEED & COMPANY

Greene, Tweed & Company, 4377 Bronx Boulevard, New York 66, has announced Palmetto Plastic Packing for which is claimed that lasting lubricating effect is obtained by combining graphite with flakes of soft anti-friction metal. These two lubricating agents are distributed evenly throughout fibers of best grade asbestos, and the whole thoroughly mixed with a special heat-resistant binder. The mixture then is formed into continuous lengths by an extruding operation which gives the packing a square outline. This shape may be altered to suit special requirements, as compression, rolling or pounding do not impair the usefulness of the packing.

This packing is claimed to provide exceptionally advantageous properties in service. The asbestos makes a strong, heat-resisiting bond, the binder gives resiliency and stability under pressure, and the graphite and metallic flakes minimize frictional wear. It does not dry out or harden in use, and in service forms a plastic metallic bushing around the rod or shaft.

The packing is recommended for air, ammonia, gases, water, mild chemicals and general services at temperatures not exceeding 550° F.

Explosion-Proof Motor

CENTURY ELECTRIC COMPANY

Century Electric Company, 1806 Pine Street, St. Louis 3, Missouri, has announced a new motor constructed to meet specifications of Underwriters Laboratories for Class I, Group C installations where the surrounding atmosphere is charged with ethyl ether vapor.

Ankle Protector

AMERICAN OPTICAL COMPANY

American Optical Company, Southbridge, Massachusetts, has designed a spat made from a coated fabric which gives the same protection as rubber but is much lighter in weight and extremely flexible. It is designed for foot and ankle protection against acids, alkalis, oils, solvents and greases.

Helps Plant Engineers Handle POWER PLANT MAINTENANCE Easier . . . Faster

NEW OAKITE DIGEST Gives Data on FAST Cleaning Techniques!

How are other plant engineers solving today's problem in equipment maintenance? What short-cuts are they finding effective? What simplified procedures and materials are saving time and money?

You will find the answers to 65 different maintenance problems in this NEW, 16-page Oakite Maintenance Digest . . . cleaning, de-scaling and related techniques that will help you keep all your equipment at peak efficiency! With this invaluable information at your fingertips, you, too, can speed-up maintenance and shorten equipment down-time.

Your Copy FREE on Request!

Write NOW for your FREE copy of this practical guide to power plant maintenance . . . no obligation, of course!

OAKITE PRODUCTS, INC.
50B Thames Street, New York 6, N.Y.
Technical Service Representatives Located in All Principal Cities of the United States and Canada

Built by Southwest

Southwest offers complete facilities for the fabrication of all types of refinery equipment, specializing in the use of alloys and clad steel. Pressure vessels, heat exchangers, storage tanks, and fractionating towers in endless variety of size and construction are custom-built in this modern plant to the most exacting specifications.

Southwest Welding & Manufacturing Co.

ALHAMBRA, CALIFORNIA

Fabricators of Steel to API-ASME and ASME Code Requirements

New Worlds
TO CONQUER IN 1945

Look out for suddenly issued orders that may quickly end much war goods manufacturing. Look for swift changes to many urgently demand peace-time products. Whenever, or whatever these changes may be, water in abundance will still be an absolute necessity.

Now is the time to check your needs for a thoroughly modern, quality built and ever dependable Layne Well Water System. You will want the best that money can buy; a water system that will last the longest, take less in up keep cost and operate at a new low in economy.

Layne Pumps and Well Water Systems have a reputation that extends around the world. They are more widely used than any other make on the face of the globe. They are serving more cities and industries than all other makes combined. As a pioneer in both well installation and pump building, Layne has created, proven and uses exclusively the greatest number of major efficiency features.

Be prepared for the changes of 1945! Get the facts about Layne Pumps and Well Water Systems now. For new literature, or the counsel of an experienced Layne engineer, address Layne & Bowler, Inc., General Offices, Memphis, Tennessee.

AFFILIATED COMPANIES: Layne-Arkansas Co., Stuttgart, Ark. ★ Layne-Atlantic Co., Norfolk, Va. ★ Layne-Central Co., Memphis, Tenn. ★ Layne-Northern Co., Mishawaka, Ind. ★ Layne-Louisiana Co., Lake Charles, La. ★ Louisiana Well Co., Monroe, La. ★ Layne-New York Co., New York City ★ Layne-Northwest Co., Milwaukee, Wis. ★ Layne-Ohio Co., Columbus, Ohio ★ Layne-Texas Co., Houston, Texas ★ Layne-Western Co., Kansas City, Mo. ★ Layne-Western Co. of Minnesota, Minneapolis, Minn. ★ International Water Supply Ltd., London, Ontario, Canada

LAYNE

WELL WATER SYSTEMS
DEEP WELL PUMPS

FOR CITIES, INDUSTRIAL PLANTS, RAILROADS, MINES, AIR CONDITIONING, IRRIGATION PROJECTS

☆ BUSINESS NOTES ☆

The M. W. Kellogg Company, Jersey City, New Jersey, has announced election of Paul Ryan as a vice president and his appointment as manager of a newly instituted consulting service which will provide counsel for oil refiners in the evaluation of factors of production, refining, transportation marketing and finance. Ryan formerly was president of National Refining Company, Cleveland, and recently has been serving in an important capacity with the Petroleum Industry War Council.

Paul Ryan

Cooper-Bessemer Corporation, Mount Vernon, Ohio, has announced appointment of A. M. Buxton as assistant sales manager, with headquarters at Mount Vernon. In addition to sharing responsibilities as general manager of sales, Buxton will direct particularly sales to the oil and gas industries, as he has been, previous to this promotion, with the company's sales force at Tulsa, and thus closely associated with these operations. He has been with the company 20 years.

A. M. Buxton

Kieley & Mueller, Inc., North Bergen, New Jersey, has appointed Clifford B. Ives as its chief engineer. Ives has been closely associated with control problems for the past 15 years and will direct the company's expansion in this field. Close cooperation with users of the company's equipment is planned, and every effort will be made to produce additional quality items to meet the requirements of the industry, an announcement said.

C. B. Ives

Turco Products, Inc., 6135 South Central Avenue, Los Angeles, has announced appointment of George F. Schemel as its petroleum-industry representative in Southern California. He will cover the territory handled for many years by Al Dekker, who has been made procurement manager for the company. Schemel is familiar with cleaning and processing problems of the petroleum industry from long experience in the field. He was for a number of years in the refining industry at Tulsa, Oklahoma.

G. F. Schemel

General American Process Equipment (Division of General American Transportation Corporation), 439 Baxter Avenue, Louisville 4, Kentucky, has appointed G. Gutzeit its research director. Dr. Gutzeit is known for his contributions to the field of metal-organic inner complexes and their application to analytical, mineralogical and metallurgical problems, and for his development of the "contact-print method" for identifying opaque minerals. He is responsible for a number of processes permitting concentration by floatation of metallic-oxide ores, and has an unusually varied experience in the chemical industry, ranging from pharmaceutical manufacture to electrometallurgy. He came to the United States in 1941 from Switzerland, where he held a professorship of complex chemistry and ore dressing at the University of Geneva, and became associated with Dorr Company. In Europe he also acted as consultant to a number of governments and industries on chemical and metallurgical problems.

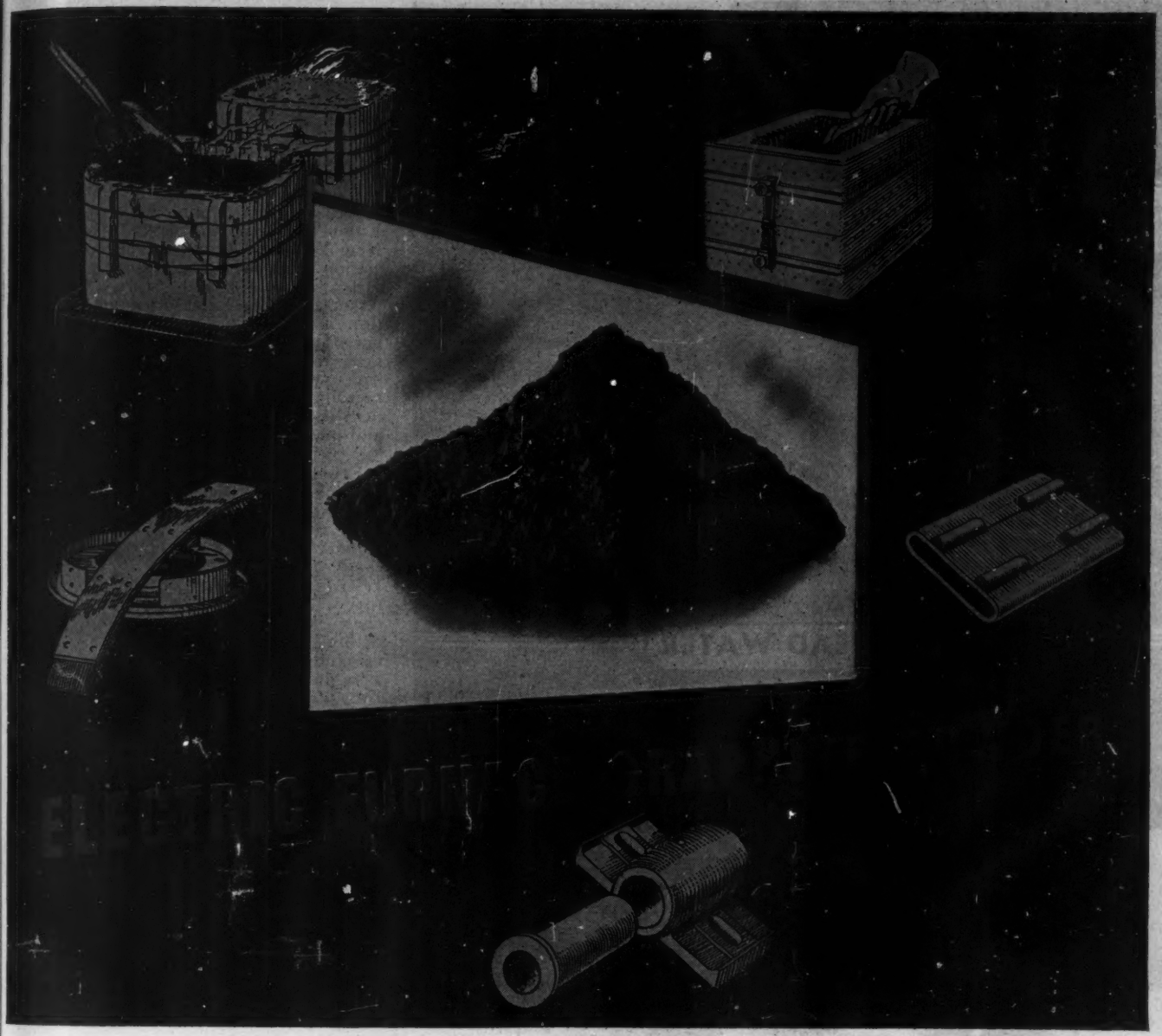
Dr. G. Gutzeit

Cardox Corporation, 307 North Michigan Avenue, Chicago 1, announces that Dr. Paul W. Leppla, formerly chief chemist of the research division, has been placed in charge of the company's electrochemical activities. Dr. John L. Gring succeeds Leppla as chief chemist of the research division. He formerly was with General Electric Company at Pittsfield, Massachusetts, and in his new position will be associated with Dr. Charles A. Getz, vice president in charge of research for Cardox Corporation.

Goetze Gasket & Packing Company, New Brunswick, New Jersey, has elected Kenneth McCreary president, to succeed Frederick Goetze who died on January 30, 1944. McCreary has been with the company since 1932, and has served as assistant to the president, treasurer and vice president and treasurer. He has outlined ambitious post-war plans for the company which currently largely is concerned with war business.

Lukens Steel Company, Coatesville, Pennsylvania, announces appointment of Martin J. Conway as manager of the Petroleum Division of Lukens Steel Company and subsidiaries, By-Products Steel Corporation and Lukenweld, Inc. Born in England, Conway was graduated from Oxford University in mechanical end chemical engineering. After experience in England with tar distillation and by-

M. J. Conway



MAKES THEM BETTER!

As a hot-topping compound, it produces sounder ingots by reducing the size of the pipe. As a mold wash, it prevents stickers. It provides brake linings with essential qualities for longer life. It is the lubricant of many oilless bearings. It is formed into electronic tube elements of high efficiency.

These are a few of the many jobs that "National" electric furnace graphite powder performs . . . to make things better!

To this end, an increasing amount of graphite powder goes each year to the iron and steel, foundry, chemical and process, petroleum, rubber, mechanical, and many other industries. Besides the applications illustrated, graphite powder is used in powder metallurgy, clutch facings, fabric belting, greases, wire drawing, rubber compounds, powder glazing, crucibles, batteries, boilers, ink and paint pigments, pencils, crayons. The list grows steadily.

"National" electric furnace graphite powder comes in a number of grades, each classified on the basis of purity, electrical resistance, and fineness . . . all held within accurately controlled limits.

Ask us how electric furnace graphite powder may help serve you . . . or serve you further.

KEEP YOUR EYE ON THE INFANTRY
. . . THE DOUGHBOY DOES IT!

The word "National" is a registered trade-mark of National Carbon Company, Inc.

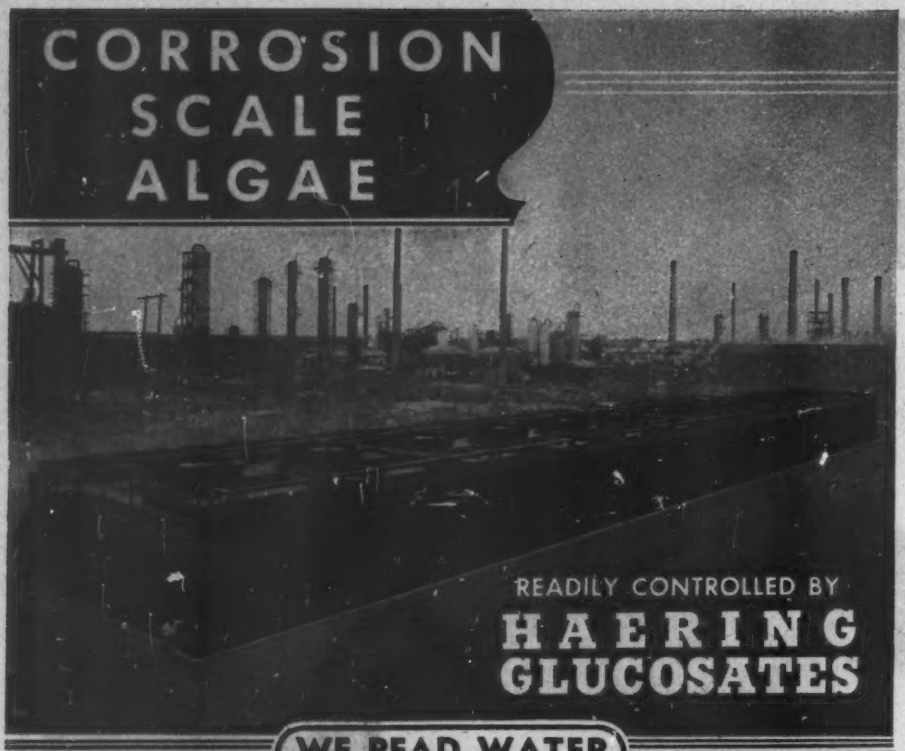
NATIONAL CARBON COMPANY, INC.

Unit of Union Carbide and Carbon Corporation

UCC

General Offices: 30 East 42nd Street, New York 17, N. Y.

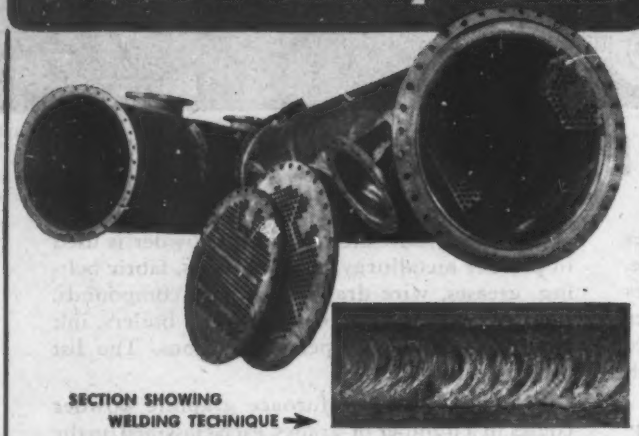
Division Sales Offices: Atlanta • Chicago • Dallas • Kansas City • New York • Pittsburgh • San Francisco



WE READ WATER

D. W. HAERING & CO., Inc.
GENERAL OFFICES:
205 West Wacker Drive, Chicago 6, Ill.

PRODUCTS by HICKS



SECTION SHOWING
WELDING TECHNIQUE →

These surface condensers, constructed of welded Naval Brass, are typical of many special fabrication problems referred to HICKS. Modern methods of manufacture will help your future plans. Hicks engineers will serve you for complete or cooperative design and planning. Send for bulletin.

S. D. Hicks & SON CO., INC.
ESTABLISHED 1841
PROCESS DIV. . . 51 E. 42 ST., N. Y. C. Phone: MU. 2-5132
PLANTS • BOSTON, MASSACHUSETTS

products of iron and coal works, he was employed in the United States by Pittsburgh Crucible Steel Corporation in 1920 as fuel engineer, subsequently was with Wheeling Steel Corporation, and joined Lukens Steel Company in the same capacity in 1926. He transferred to the sales department as special engineer in 1940. He is a fellow of the Institute of Fuel, member of ASME, AIME, Association of Iron and Steel Electrical Engineers, Iron and Steel Institute of New York and London, National Association of Power Engineers, American Military Society and Army Ordnance Association. He is credited with invention of the recuperative open hearth furnace and improved methods of manufacturing of wrought iron and metallic iron properties. He is author of numerous papers on fuel economy liquefied petroleum gases, uniflow engines and many other subjects.

Ethyl Corporation has announced return of George Krieger to its organization after two years with the farm machinery division of the War Production Board at Washington. He will be in charge of rural marketing and special development work as assistant to Julian J. Frey, general sales manager. Before going with WPB, Krieger was head of the agricultural division of Ethyl Corporation's technical service department, with headquarters at Detroit. Graduating from Virginia Polytechnic Institute in 1926, he entered the refinery research laboratories of Standard Oil Company of New Jersey at Bayway, and joined Ethyl Corporation in 1929 as an agricultural engineer. He has held important posts with the American Society of Agricultural Engineers and the Society of Automotive Engineers.

George Krieger

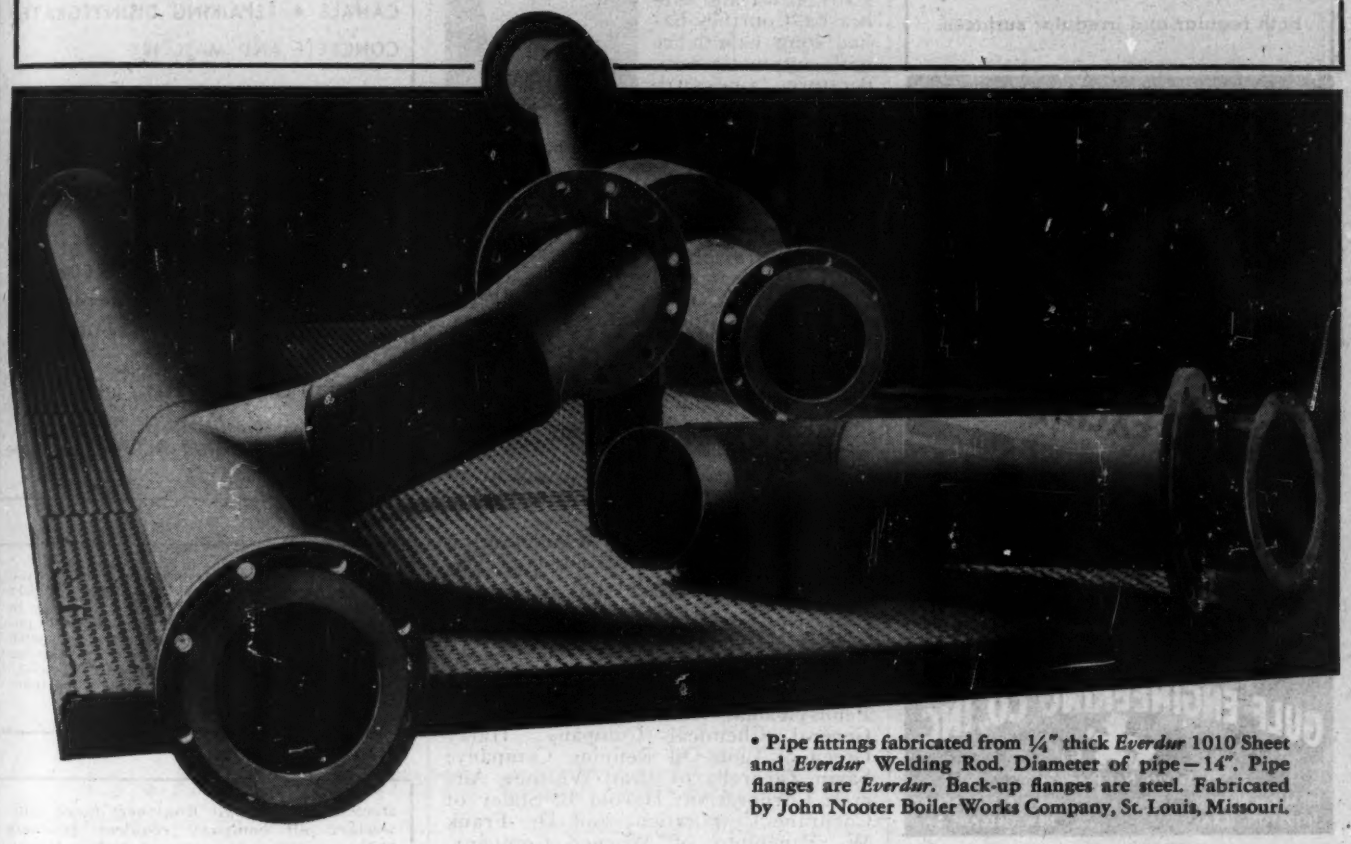
Pyrene Manufacturing Company, Newark, New Jersey, has formed Pyrene Development Corporation as a subsidiary to carry out research on fire-extinguishing equipment and compounds, and safety devices. An immediate project is extension of development of systems and equipment for application of the mechanical foam principle in fire extinguishment. Officers of the subsidiary, all executives of the parent organization, include C. G. Durfee, president, E. J. Waring, vice president, and E. A. Clapp, secretary and treasurer.

The Watson-Stillman Company, Roselle, New Jersey, has appointed J. T. Gillespie, Jr., manager of export sales. Gillespie is a graduate of Taft School and Yale (Ph.B., 1926). During the past 2½ years he has been with the shipbuilding division of the War Production Board as chief of staff branch, and previously with the contract distribution division as chief of the liaison section with the Maritime

J. T. Gillespie, Jr.

Everdur combines...

HIGH STRENGTH AND CORROSION RESISTANCE IN THESE WELDED FITTINGS



• Pipe fittings fabricated from ¼" thick *Everdur* 1010 Sheet and *Everdur* Welding Rod. Diameter of pipe—14". Pipe flanges are *Everdur*. Back-up flanges are steel. Fabricated by John Nooter Boiler Works Company, St. Louis, Missouri.

"Fabricated from *Everdur*," is often encountered in specifications from oil refinery and chemical processing industries. For plant equipment and fittings that must stand up under continuous operation and resist many types of corrosive agents, *Everdur** (copper-silicon alloy) is frequently preferred.

Everdur is a special, high strength alloy of The American Brass Company. It provides corrosion resistance, equal to or exceeding that of copper and it can be readily worked—and welded with rods of similar composition.

Investigate *Everdur*. Inquiries for technical information on particular plant equipment problems are invited. 44153

THE AMERICAN BRASS COMPANY
Subsidiary of Anaconda Copper Mining Company
General Offices: Waterbury 88, Conn.
In Canada: Anaconda American Brass Ltd., *New Toronto, Ont.*
*Reg. U. S. Pat. Off.

For your security BUY WAR BONDS

ANACONDA

Everdur Copper-Silicon Alloy

Eagle "66"

PLASTIC INSULATION

★ All Purpose Insulation: This plastic can be applied to virtually any type of heated equipment. It forms monolithic insulation over both regular and irregular surfaces.

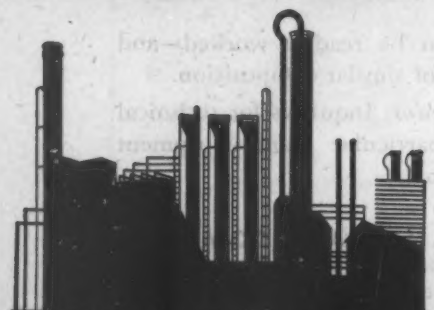
The INDUSTRIAL INSULATORS
HOUSTON, TEXAS ★ SHREVEPORT, LA

QUICK REPAIRS ON CONDENSERS and HEAT EXCHANGERS

If you need condenser or heat exchanger repairs **in a hurry** call us. We specialize in fast, high quality work.

25 Years Successful Experience

GULF ENGINEERING CO., INC.
Service Not Promises
107 M & M BUILDING HOUSTON, TEXAS
916 S. PETERS STREET NEW ORLEANS, LA



We design and construct all types of modern refining units.

★ Serving the Industry Since 1915

BORN ENGINEERING CO.
Tulsa, Oklahoma

Commission, on leave from Air Reduction Company, with which he was assistant to the president of Wilson Welder & Metals Company, a subsidiary. His export experience was gained through several years with L. C. Gillespie & Sons, exporters and importers of raw materials.

General Controls Company, Glendale, California, recently has opened a branch office at 421 Southwest Boulevard, Kansas City 8, Missouri, with Robert Courtney in charge as branch manager. This office will serve Kansas and adjacent areas of Missouri, Iowa and Nebraska. Courtney has had long experience with automatic temperature, pressure and flow controls and their industrial application.

Robert Courtney

General American Process Equipment, 420 Lexington Avenue, New York, has appointed O. R. Kuster chief project engineer. Kuster has had wide experience in chemical plant design in the Netherlands, Russia, Chile and the United States, specializing in fertilizers, potash, aluminum and magnesium salts. He formerly was with The Dorr Company.

National Tube Company has announced election of Leo J. Mason of Gary, Indiana, as a vice president of the company.

Pennsylvania Salt Manufacturing Company, 1000 Widener Building Philadelphia 7, announces the following additions to its research and development staff: Miss Isabella A. Romans, formerly with Chloramine Corporation; Dr. George McCoy, formerly instructor of organic chemistry at the University of Pennsylvania; Ward W. Whitebread of General Chemical Company; Harry Green of Lion Oil Refining Company; Savin Zavarella of Pratt-Whitney Aircraft Corporation; Harold B. Staley of Cochrane Corporation; and Dr. Frank W. Panepinto of Warner Company. New staff members also include Miss Mary F. Hensler and Miss Helen Cunningham of the College of Chestnut Hill and Miss Mildred E. Raesler of Pennsylvania State College.

Dresser Industries, Inc., has moved its headquarters from Bradford, Pennsylvania, to Cleveland, Ohio, where executive offices are located in Terminal Tower. Dresser Industries, Inc., is the parent corporation of a group now comprising 10 companies, in related lines of manufacture. The factory of Dresser Manufacturing Division, up to now the parent corporation of the Dresser group, will remain at Bradford. Other member companies in the group include The Bryant Heater Company and Van der Horst Corporation of America, Cleveland; Clark Bros., Co., Inc., Olean, New York; Pacific Pumps, Inc., Huntington Park, California; International Derrick & Equipment Company, Columbus, Delaware and Marietta, Ohio, Beaumont, Texas, and Torrance, California; Roots-Connersville Blower Corpora-

"GUNITE"
CONCRETE LININGS

FOR:

BUBBLE TOWERS • STILLS • HOT OIL SEPARATORS • STORAGE TANKS • REFINERY VESSELS OF ALL TYPES • ENCASING AND FIREPROOFING STRUCTURAL STEEL AND PIPE • LINING WATER STORAGE RESERVOIRS, DITCHES AND CANALS • REPAIRING DISINTEGRATED CONCRETE AND MASONRY.

WRITE — PHONE — WIRE

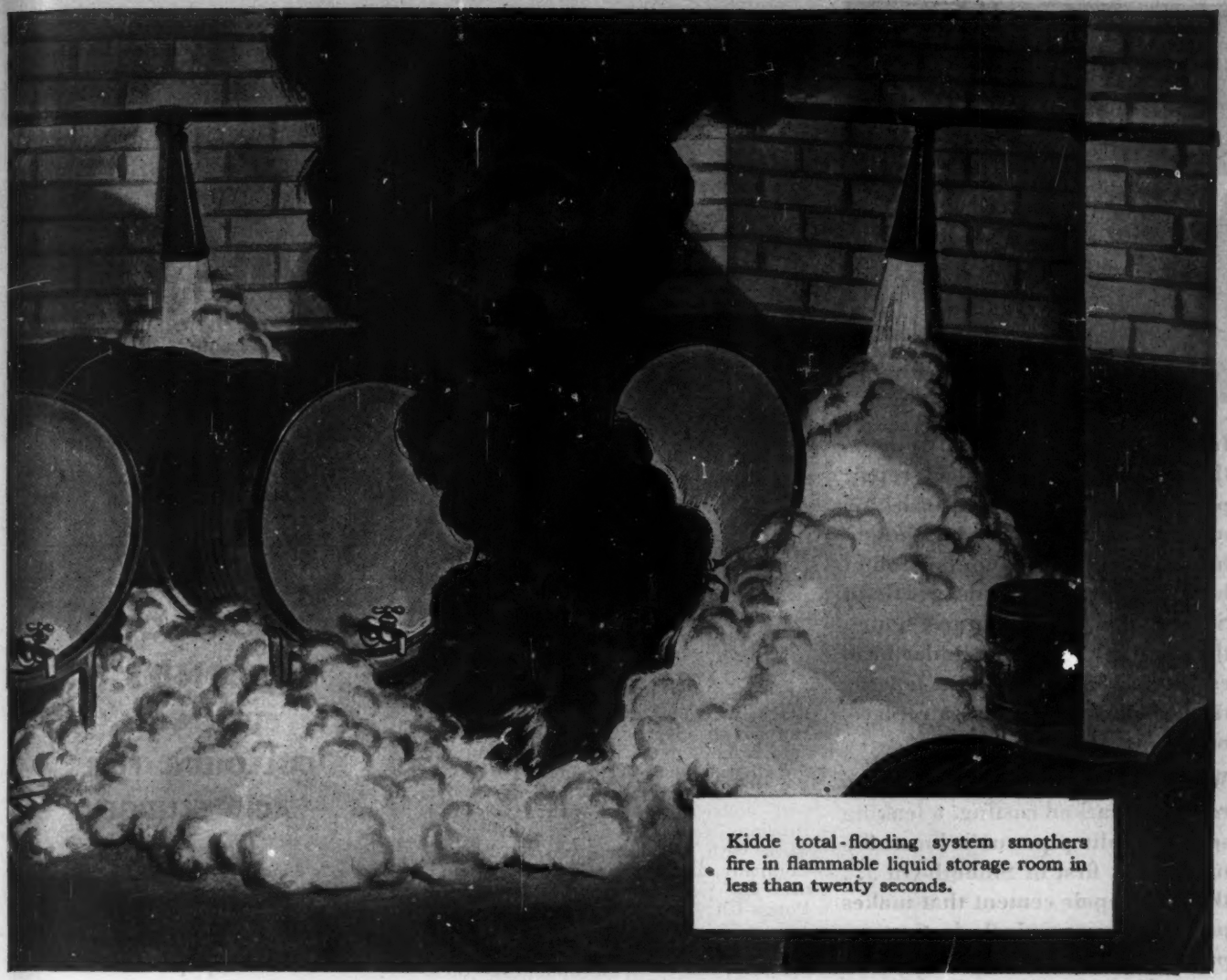
GUNITE CONCRETE and CONSTRUCTION CO.
CEMENT GUN SPECIALISTS
ENGINEERS CONTRACTORS
1301 Woodswether Road
KANSAS CITY 6, MISSOURI
District Branch Office:
228 NORTH LA SALLE STREET, CHICAGO, ILL.
Branch Offices:
ST. LOUIS DENVER NEW ORLEANS HOUSTON

Inspector wanted—Mechanical engineering degree or suitable equivalent to inspect equipment in chemical plant located in metropolitan Detroit area. Permanent position. Must be thoroughly familiar with pressure vessels, piping, etc. Write giving full details including references and salary desired. Address: Box 508, c/o Petroleum Refiner, Houston, Texas.

Mechanical or Civil Engineer, large midwestern oil company requires graduate M.E.'s or C.E.'s for refinery design, layout, and inspection work, with a real post-war future. Write Box 111, c/o Petroleum Refiner, Houston, Texas, giving qualifications and experience if available under WMC regulations.

MECHANICAL ENGINEER — A well-established manufacturer with national reputation requires the services in Tulsa of a top-flight Mechanical Engineer, preferably with welding experience. Electrical knowledge would be desirable. This position is in connection with the development of products in the petroleum and chemical fields. It has excellent post-war possibilities. Those who are connected with the war effort at their highest skill should not reply. Please enclose a small photograph which will not be returned with your application. Address: Box 26, c/o Petroleum Refiner, Houston, Texas.

Wanted: Research Chemist, must have Master's degree or equivalent with several years of experience in asphalt research and technology. Must be well versed in asphalt specialties, asphalt emulsions. Must be capable of taking complete charge of permanent research program. Address: Box 36, c/o Petroleum Refiner, Houston, Texas.



Kidde total-flooding system smothers fire in flammable liquid storage room in less than twenty seconds.

BEFORE TOUGH FIRES GET TOO TOUGH

. . . *blast them out with Kidde!*

In fighting the tough gasoline and oil fires you've got to smother them *fast* before they spread beyond control.

That's one of the jobs for which Kidde equipment is designed — and specifically approved by Underwriters. Clean, dry, inert carbon dioxide, released under high pressure, snuffs out the blaze in a matter of seconds, leaving no after-fire mess to be cleaned up . . . keeping petroleum products free from contamination, dilution or other damage.

Kidde built-in systems, employing this fast, safe fire-killing agent, can be engineered to control a fire hazard automatically, by flooding it with carbon dioxide. And Kidde equipment is equally effective for extinguishing fires that break out in your electrical equipment — for it carries all laboratories' approval for *both* flammable liquid (Class B) and electrical (Class C) fires.

Check this list today. Does even *one* of these hazard areas need protection in your plant? If it does, call in a Kidde representative. He'll be glad to share his fire-prevention know-how with you. Write us today.

KIDDE KILLS TOUGH FIRES

- Storage Rooms
- Pump Rooms
- Tank Trucks
- Electrical Equipment
- Paint Storage
- Antifreeze Rooms
- Pipe line pumping stations
- Case and Can Rooms
- Control Rooms
- Laboratories
- Bulk Plants

Walter Kidde & Company, Inc. • 140 Cedar Street • New York 6, N. Y.

SMOOTH-ON
REPAIR
RECORDS
CRACKED DIESEL ENGINE HEAD
200 HP Engine
Repaired without heat
This large crack between water jacket and air-starting valve cage was repaired by removing the head, inserting a pipe sleeve, and tamping Smooth-On No. 1 into crack and between sleeve and casting as shown.
Repair withstands 300 lb. starting air pressure
FOLLOW THIS SERIES OF SMOOTH-ON SAVINGS

In this instance, as in many others, the Smooth-On method of repair prevented the danger of cracking or warping the head, which might have occurred from application of heat. With a few cents worth of Smooth-On, and within five hours, the engineer saved a cylinder head costing $165.00 plus the lengthy time required to secure a replacement.

Whenever you are called upon to repair a cracked casting, a leaking seam, a split pipe, or a loose fixture, think first of Smooth-On . . . the iron repair cement that makes practical, economical, lasting repairs without requiring the use of heat, dismounting of parts, or special skill.

Buy SMOOTH-ON in 7-oz., 1-lb., or larger containers from your supply house, or if necessary, from us. For your protection, insist on SMOOTH-ON, used by engineers and repair men since 1895.

FREE

REPAIR HANDBOOK SHOWS HOW

40 pages, 170 diagrams, and simple concise instructions for practical repairs to plant equipment, pipe lines and structures. A necessity in every plant. Your copy sent FREE if you fill in and return the coupon.

SMOOTH-ON MFG. CO., Dept. 11
570 Communipaw Ave., Jersey City 4, N. J.
Please send SMOOTH-ON HANDBOOK

Name.....

Address.....

.....

12-44

Do it with **SMOOTH-ON**
The Iron Repair Cement of 1000 Uses

tion, Connersville, Indiana; Stacey Brothers Gas Construction Company, Cincinnati, Ohio; Bovaird & Seyfang Manufacturing Company, Bradford, Pennsylvania, and Dresser Manufacturing Company, Ltd., Toronto, Canada.

S. R. Edwards

Yarnall-Waring Company, Chestnut Hill, Philadelphia 18, has announced opening of a new Southwestern sales office at 805 Texas Bank Building, Dallas, Texas, in charge of S. R. Edwards. Edwards is a graduate of Purdue University in mechanical engineering, and has had 15 years experience in sales and engineering work.

Fisher Governor Company, Marshalltown, Iowa, announces appointment of Malcolm W. Black & Company, 41 East 42nd Street, New York, as its representative in the metropolitan New York, including Northern New Jersey and Connecticut. Staff of engineers attached to the office includes A. W. Bailey, who has been associated with Fisher Governor Company for the past 20 years. Black, who heads the New York company, is an electrical engineering graduate from University of Oklahoma and for 10 years has been sales representative for Manning, Maxwell & Moore, with district headquarters at Tulsa. Previous experience included meter work with Oklahoma Gas & Electric Company, and as chief instrument engineer for Continental Oil Company at Ponca City, Oklahoma,

Mixing Equipment Company, Rochester, New York, has announced these changes in its sales organization: Emerson Scheuring Tank & Manufacturing Company, Indianapolis, will act as representative for Central Indiana. White Industrial Sales & Equipment Company, Cincinnati, will represent the company in Southern Ohio, Northern Kentucky and Western West Virginia, including Charleston. This West Virginia area formerly was covered by Moorhead Company, Pittsburgh, and the New York office of Mixing Equipment Company. Arrangement under which E. W. Buschman Company, Cincinnati, has handled part of this territory for a number of years has been terminated by mutual consent, it was said.

The B. F. Goodrich Company, Akron, Ohio, has appointed W. A. Smith manager of suspension sales, the department which handles the company's products and devices for isolating vibration and noise. Smith has been with the company since 1924, and recently was technical representative in the Washington office.

Globe Steel Tubes Company, Milwaukee 4, has appointed Frederick K. Krell advertising manager with headquarters with the general sales department in Milwaukee. Krell is the immediate past president of the Milwaukee Junior Chamber of Commerce, and at present is chairman of the trade promotion committee of the United States Junior Chamber of Commerce and state director of the Wisconsin Junior Chamber of Commerce.

FOR SALE
New and Reconditioned Iron & Steel
VALVES
Tested and Guaranteed
LARGE STOCK OF FITTINGS
APEX IRON & METAL CO.
2204 S. Laflin St. Chicago 8, Ill.

DRAFTSMEN

For Process Piping on Oil Refineries; also Designers and Checkers on Pressure Vessels.

Applications solicited from men not now employed in essential work or those completing essential work who have Statements of Availability.

ARTHUR G. McKEE & COMPANY
2300 Chester Avenue
Cleveland, Ohio

EMULSIONS
BLENDS
CUT BACKS
COLLOIDAL FUEL
ACID SLUDGE
SLOP OIL
SYNTHETIC FUEL
For Processing Machinery and Equipment
WRITE TO THE
VOLCANIC SPECIALTIES COMPANY
ALLIANCE, OHIO

McNAMAR
Steel Plate
Fabricators and Contractors
•
Products Storage
•
Pressure Vessels
•
For more information
See Page 371
in Refinery Catalog
McNAMAR
BOILER & TANK CO.
Tulsa, Okla. — Salem, Ill.

PETROLEUM
REFINER

ENGINEERING
LIBRARY

JAN 10 1945

Hanlon-Buchanan, Inc
PIONEER NATURAL GASOLINE MANUFACTURER

EXPORT TERMINALS:
Goodhope, La. Corpus Christi, Tex.
Houston, Texas Texas City, Texas
Baytown, Texas Galena Park, Texas

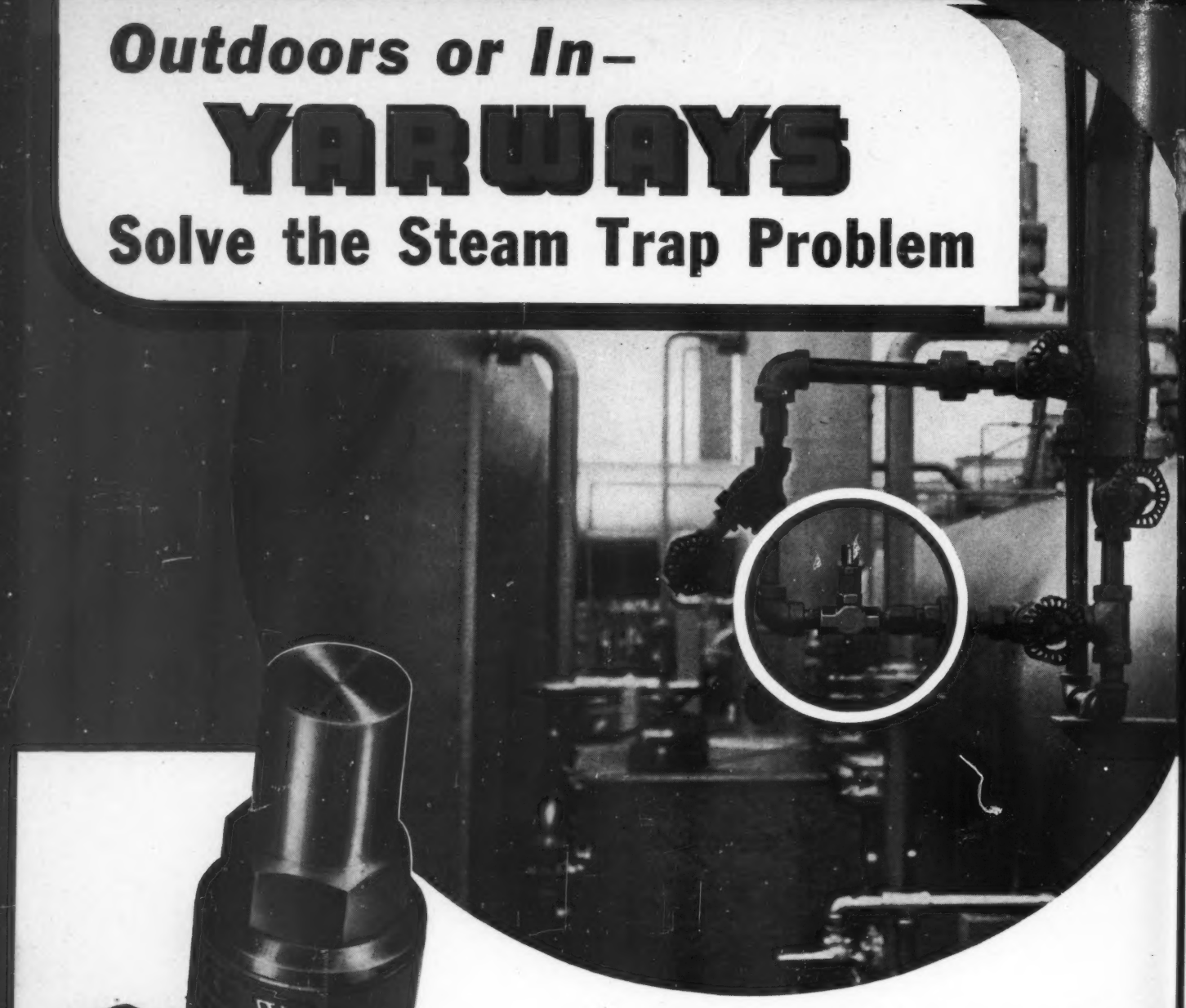
TULSA, OKLAHOMA
NATIONAL BANK OF TULSA BUILDING
PHONE 4-1101 or L.D. 358 WIRE — OR WRITE P. O. BOX 1559
Cable Address . . STAVOLENE, Tulsa, U. S. A.

FOREIGN REPRESENTATIVE:
Barks, Williams & Co., Ltd.
4 Lloyd's Ave.
London, England

Outdoors or In—

YARWAYS

Solve the Steam Trap Problem



ON all kinds of steam heated equipment and steam ma throughout refineries, both indoors and outside exposed the elements, you will find Yarway Impulse Traps on the j

These steam traps are "NATURALS" for refinery servic have been purchased by the thousands by some oil compani

The advantages of standardizing on Yarway Impulse Tr are important both to plant operation and maintenance.

First—These traps are *good for all pressures* within a wi range *without change of valve or seat*—permitting a gr reduction in inventory of spare traps and parts.

Second—They *speed up heating up* and *keep equipment hot* because they provide *continuous discharge on heavy condens loads*, quickly clearing lines of water and air, and *intermitt discharge on light loads*, keeping them free of condensate.

Third—Their *simple design* with *only one moving part* little valve, makes them trouble-free—easy to maintain.

Fourth—Their *low price* often makes it cheaper to instal new Yarway than to repair an ordinary trap.

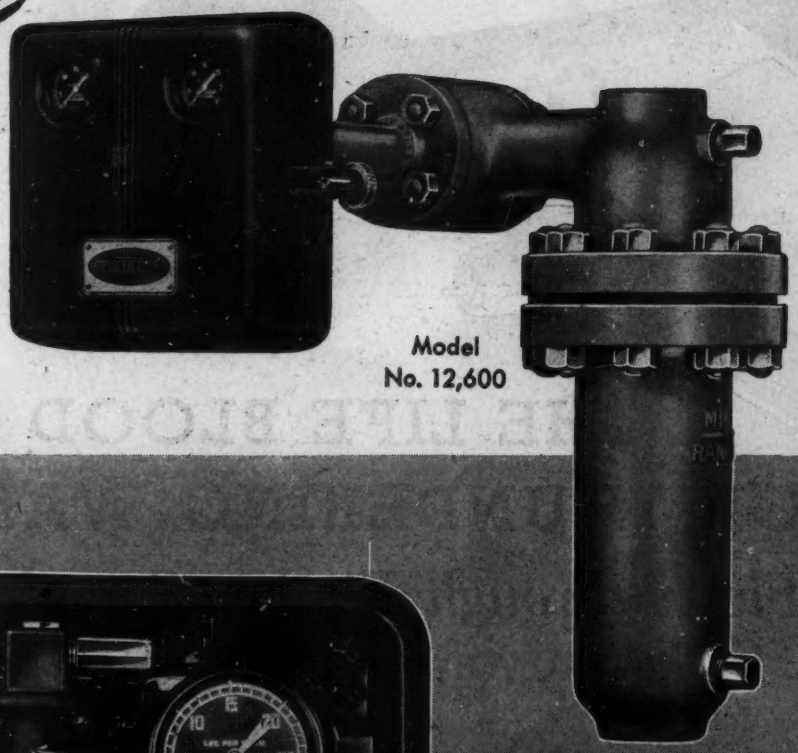
Ask your mill supply dealer or write for Catalog T-1737.

YARNALL-WARING COMPANY
128 Mermaid Ave. Philadelphia

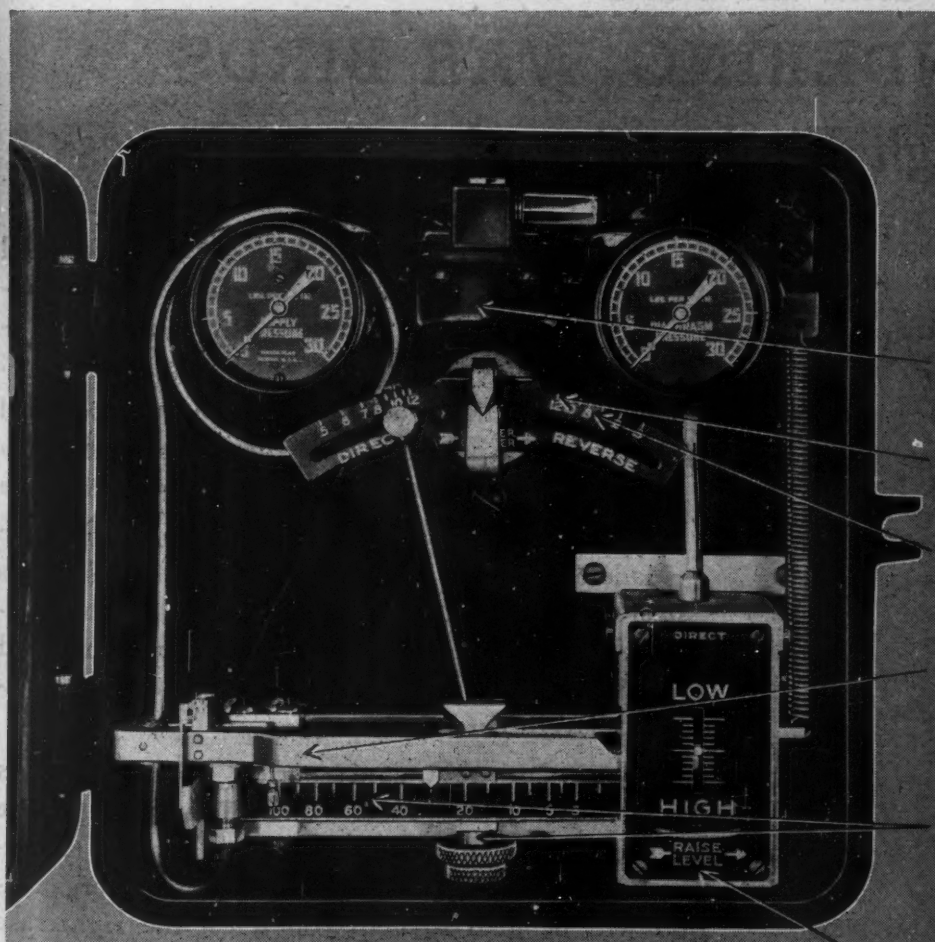
YARWAY IMPULSE STEAM TRA

Level Controllers

Liquid Level



Model
No. 12,600



Pilot. Large area metal bellows and great air capacity. Unit mounting, eliminating any major air tubing connections.

Calibrated Specific Gravity Scale. Adjustable from .5 to 1.2 sp. gr. or from .8 to 2.0 sp. gr.

Control Action. The control action is always clearly indicated and the procedure to reverse the action is simple.

Control Mechanism. New principle. Sensitive to .001" change in level. Complete elimination of pivot bearings. Proportional band adjustment without high multiplication.

Proportional Band. Calibrated 1 to 100%. Over 4" scale. Linear proportional characteristics to close limits in all settings. Adjustment with minimum upset of control point setting.

Convenient Setting Index Scale. Wide scale provides control point setting through full level range. Vernier knob for smooth and positive adjustment.

REGULATOR COMPANY

Boston 24, Mass., U. S. A.

St. Louis San Francisco Los Angeles Houston Mason Regulator Co. of Canada, Ltd., Montreal

THE LIFE BLOOD
OF THUNDERING WAR BIRDS
Flows through Timken Seamless Steel Tubes

Producing high-octane gas, the life blood that makes our planes living things endowed with thunderous power, involves tremendous working pressures and fierce heat.

Because the quality of Timken Seamless Steel Tubes for pressure applications is guarded from melt shop to finished tube inspection, they are able to stand up under this gruelling punishment.

Made in carbon, intermediate alloy and stainless steel grades these fine tubes are used with confidence by petroleum refiners throughout the world to combat conditions of high temperature, high pressure and severe corrosion.

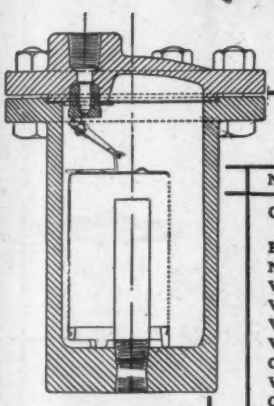
When you plan new construction or replacements specify Timken Seamless Steel Tubes. They will provide longer life, less down time and will minimize maintenance. If you like, a member of our technical organization will be glad to help you select the right tube for your refinery; or a request written on your firm's letterhead will bring data on a large number of steels for high temperature service.

Steel and Tube Division, The Timken Roller Bearing Company, Canton 6, Ohio.

TIMKEN
TRADE-MARK REG. U. S. PAT. OFF.
SEAMLESS STEEL TUBES

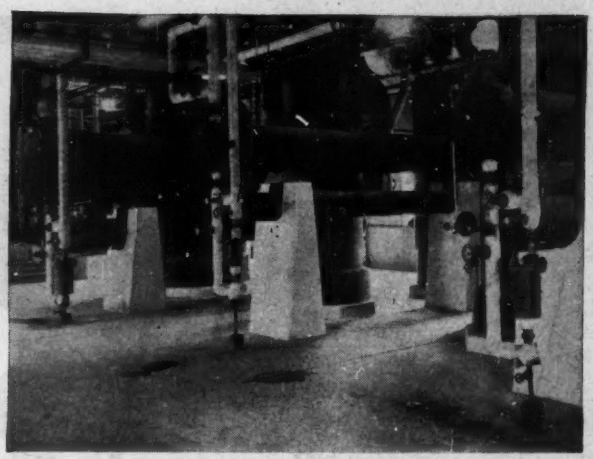
FORGED STEEL STEAM TRAPS...for

HIGH PRESSURES
"ALL STEEL" INSTALLATIONS
MAXIMUM SAFETY



LIST OF MATERIAL
(TRAPS NO. 312-515)

NAME OF PART	MATERIAL
Cap and Body	Die Forgings (S.A.E. 1030) 79,000 lbs. Tensile Strength
Bolts	Super Temp. 149,000 lbs. Tensile
Nuts	Hex. Semi-Finish (S.A.E. 1030)
Valve	Chrome Steel (Heat Treated)
Valve Retainer	18-8 Stainless Steel
Valve Lever	18-8 Stainless Steel
Valve Guide Plate	18-8 Stainless Steel
Guide Plate Screw	18-8 Stainless Steel
Valve Seat	Chrome Steel (Heat Treated)
Gasket	Compressed Asbestos Graphited or Soft Iron
Bucket Assembly	18-8 Stainless Steel
Inlet Tube	Wrought Iron



As high pressure power plants were developed, Armstrong concurrently developed forged steel inverted bucket steam traps for pressures above 250 lbs., finally arriving at traps capable of safely withstanding 2400 psi. In recent years, however, the advantages of these traps have not been confined to high pressures, the trend in power plants and refineries being to use steel fittings and steel traps widely for lower pressures, often with welded joints. This practice eliminates any danger of fracture due to explosions or fires. Armstrong Steel traps are the last word in quality and durability.

When engineering steel installations, be sure to have complete data on Armstrong Forged Steel traps. Ask for a copy of the ARMSTRONG STEAM TRAP BOOK.

ARMSTRONG MACHINE WORKS
852 Maple Street • Three Rivers, Michigan

ARMSTRONG

For any Refinery System . . . Crane supplies all piping parts

ONE SOURCE OF SUPPLY . . . ONE RESPONSIBILITY FOR MATERIALS

You'll find it a lot easier to get started and keep moving on war-deferred replacement work by using Crane *complete* piping materials service. It simplifies the job—from ordering of parts to making installations. One source—your Crane Branch or Wholesaler—supplies everything you need—valves, fittings, pipe, piping accessories and fabricated assemblies. You choose from the world's most complete selections—in brass, iron, and steel—in all pressure classes.

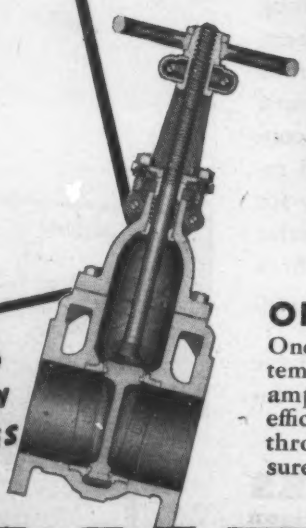
One order covers everything. One responsibility—Crane—for the quality of all parts helps assure the best installation. In addition, by using Crane materials throughout each job, you get full benefit of 89 years' experience and leadership in satisfying industry's piping needs.

CRANE CO., 836 S. Michigan Ave., Chicago 5, Ill.
Branches and Wholesalers Serving All Industrial Areas

Cooling Unit in Large Oil Refinery Electric Generating Plant.

PIPING EQUIPMENT BY CRANE . . . 100%

- Gate Valves
- Flanges
- Clamp Gate Valves
- Welding Fittings
- Pipe
- Screwed Fittings
- Safety Valves
- Globe Valves
- Check Valves
- Separators
- Unions
- Flanged Fittings



STANDARD IRON BODY WEDGE GATE VALVES

ONE STANDARD OF QUALITY

One highly dependable quality guards every part of piping systems when Crane materials are used from end to end. For example, here's how Crane Iron Body Valves increase pipe line efficiency. Strong body sections resist severest stresses. Straight-through ports permit unrestricted flow. A deep stuffing-box insures tightness and lengthens packing life.

CRANE

VALVES • FITTINGS • PIPE
PLUMBING • HEATING • PUMPS

WHERE ACCURACY IS INSURED

. . . . out in the field!

ALL OF the many significant Westcott-AMERICAN refinements in construction have a single purpose . . . a practical meter that will hold its fine in-built sensitiveness and accuracy—no matter how rigorous the conditions of service, whether for Indicating, Recording or Integrating instruments.

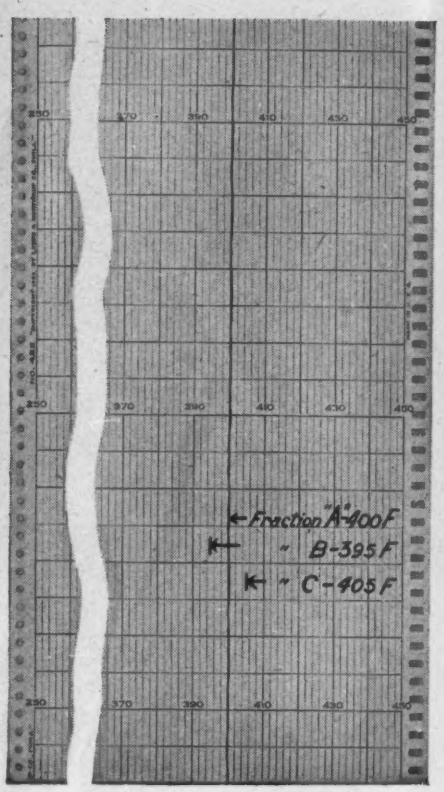
▪ Accuracy must be built into a meter. In the Westcott-AMERICAN orifice meter, it is embodied in a score of outstanding features: The precision machining of the differential gage body chambers . . . the low angle of travel of the float . . . the small angular travel of the static pressure tube . . . only one movable part between the mercury surface and the chart record.

▪ Printed or personal engineering information is available on request. Specifications on the popular Round Case Indicating Flowmeter also may interest you.

D-344

AMERICAN METER COMPANY
INCORPORATED (ESTABLISHED 1836)
GENERAL OFFICES • 60 EAST 42nd STREET, NEW YORK 17, N. Y.

Two of the several dozen Micromax Pneumatic Controllers used to regulate temperatures of furnaces, tower tops and reboilers in the Clarkson, Ont., refinery of British-American Oil Co., where petroleum war products are made.



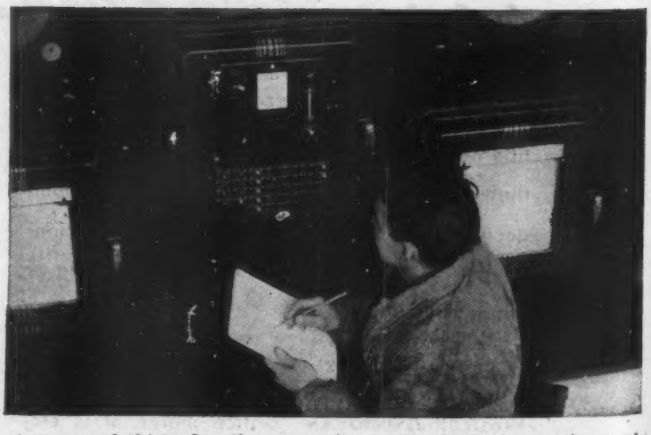
Reduced section of typical Micromax Pneumatic Controller chart, marked up to show other fractionation points whose nearness makes the steadiness of Micromax so valuable when maximum throughput is desired.

DOWN "B-A'S" 10-DEG. CORRIDOR WITH MICROMAX CONTROLLERS

The temperature limits into which nature has crowded several of the petroleum fractions are narrow—but in British-American Oil Co.'s refinery each one is compelled to respect the territory of its neighbor. For B-A has found that even the closest temperature-neighbors can be kept from trespassing on each others' lines when the fractionation is regulated by Micromax Pneumatic Controllers.

The reason? The Micromax quality called micro-responsiveness. Micromax *feels* temperature changes too small to *see;* feels them, and moves the fuel valve in strict proportion to their extent. It throttles fuel up and down . . . down and up again . . . holding temperature in the narrow limits of the particular fractionation.

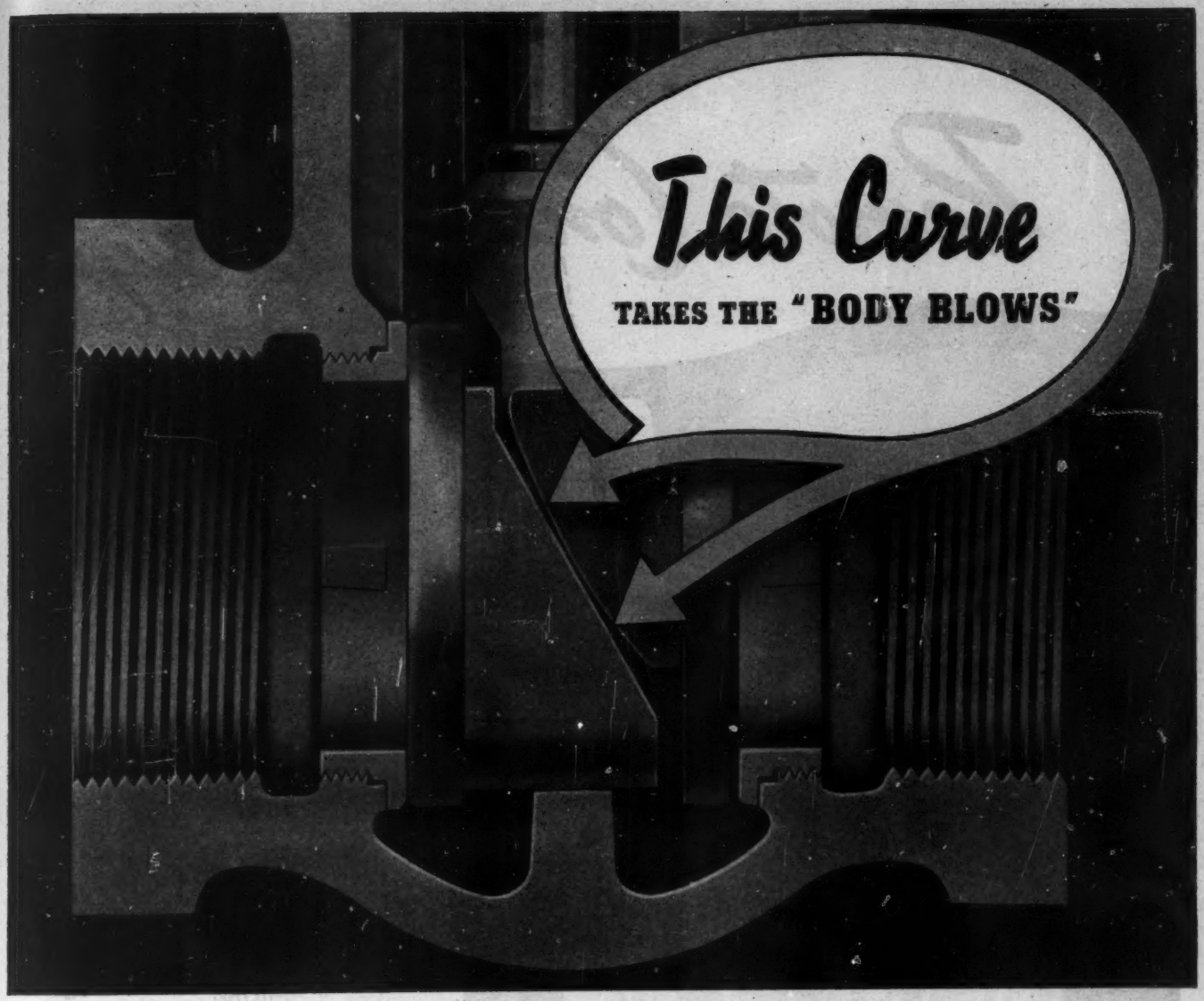
For further information, see Catalog N-OOB, "Micromax Pneumatic Control."



Any one of thirty-five thermocouples, most of which are also used with recording instruments, can be checked with this L&N Indicator in the B-A plant at Clarkson.

Jrl Ad N-33A702(62)

LEEDS & NORTHRUP COMPANY, 4923 STENTON AVE., PHILA. 44, PA.
LEEDS & NORTHRUP
MEASURING INSTRUMENTS · TELEMETERS · AUTOMATIC CONTROLS · HEAT-TREATING FURNACES



LINE strains, high temperatures and pressures will distort the body of any valve. Only Darling fully revolving double disc parallel seat gate valves have the curved wedge face and transverse bevels that permit the gate to adapt itself to out-of-line positions the valve seats may assume. There's no need to jam or force it; it fits naturally, easily and tightly.

The valve assembly consists of four simple parts—two discs, two wedges. These can easily be removed for inspection or maintenance without taking the valve from the line. When the valve closes, the two wedges force the discs firmly against the valve seats. On opening, the first quarter-turn instantly releases the wedges and frees the discs to be raised with less seating wear.

The discs are fully revolving through 360° and seat themselves in a different position each time the valve is closed. Thus wear on disc and seat is uniform, and life-long, tight closing results.

For drop-tight closing, year after year, for long, economical, trouble-free service, specify Darling Valve.

TRADE DARLING MARK

VALVE & MANUFACTURING CO.
WILLIAMSPORT, PA.

Remote Control Design Simplified

• Remote Mechanical Controls have been made the subject of much careful, detailed study by Bayard Engineers.

As a result, a complete line of such controls has been developed, embracing many exclusive and advantageous features of simplicity.

A detailed description of this series, together with explanatory diagrams for their practical application, is contained in Manual A-100, just off the press.

Your copy of Manual A-100 will be sent to you, for your study and consideration, upon inquiry. It contains much information you will want to keep in your "ready reference" file.

Five-time Winner of the Navy "E"

M. L. BAYARD & CO., Inc. • ENGINEERS • MACHINISTS

BAYARD

20TH & INDIANA AVE. PHILA. 32, PA.

SMITHway Electrodes in Action on a B-29 Boeing Super Fortress. Saving 206 important pounds per landing gear at a time when it had to be done . . . stepping up design stress to over 100,000 lbs. per square inch . . . made possible with SMITHway Certified Electrodes and SMITHway welding technique.

PRODUCTION puts its O. K. in a big way on SMITHway Certified Electrodes. Hundreds of millions of these "special analysis" electrodes — developed by and for the A. O. Smith Corporation, largest manufacturer of welded steel products — have welded hundreds of thousands of tons of the biggest, toughest steel jobs on record . . . proving they can produce more welds per man-hour at minimum cost.

No other electrodes offer such outstanding performance-proof. No other electrode manufacturer has such complete controls . . . including engineering research laboratory controls, plus complete quality-and-service controls of raw materials and processing . . . plus constant production-line inspection controls and mass-production analyses.

These production-proved SMITHway Certified Electrodes now are available also to you — immediately — from warehouse stocks in principal industrial areas. Phone, wire, or write our nearest office.

Mild Steel . . . High Tensile . . . and Stainless Steel

WELDING ELECTRODES

made by welders . . . for welders

Have You Bought That Extra War Bond This Month?

SMITHway A. C. Welding Machine saves power; eliminates arc blow.

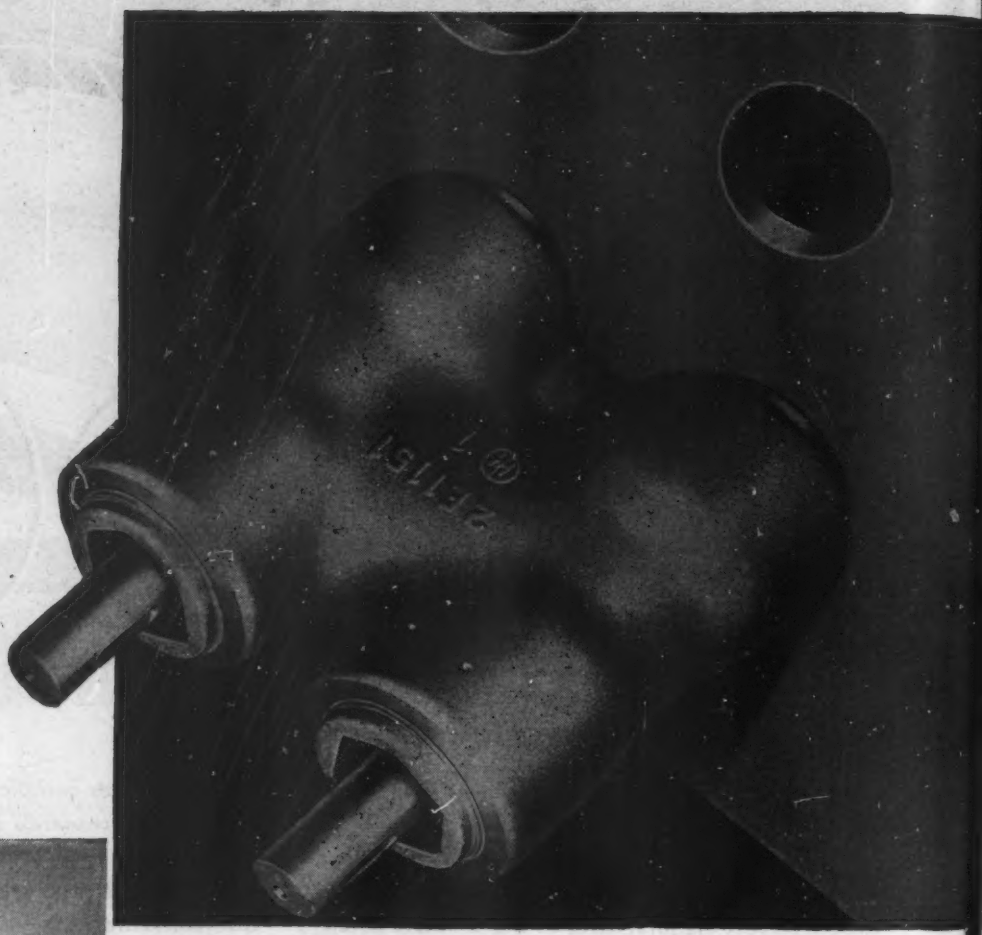
SMITHway Welding Monitor trains better welders faster.

A. O. SMITH Corporation

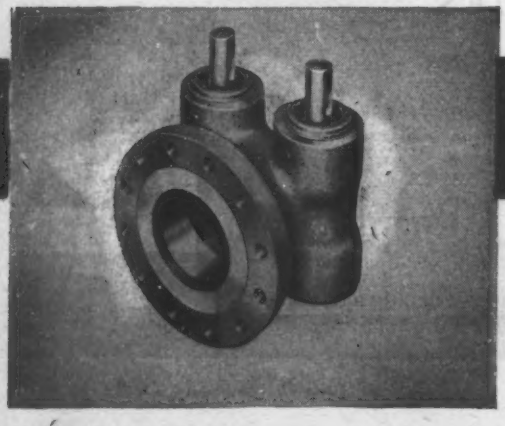
MILWAUKEE • WISCONSIN • HOUSTON • TEXAS

In Canada — JOHN INGLIS CO., LIMITED

Here's why OHIO TYPE

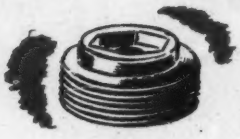
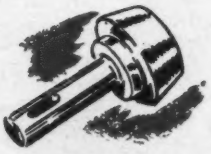


Above: Flanged terminal fitting.
Below: Type 1600 with flanged side outlet.



THE OHIO STEEL

1600 RETURN BENDS ARE SAFE:

WHEN DISMANTLING FOR CLEANING, THE CIRCULAR  HOLDING-MEMBER IS NOT ENTIRELY REMOVED UNTIL AFTER THE PLUG  IS LOOSENED. SHOULD EXPLOSION OCCUR, IT IS CONFINED TO THE INTERIOR TOP STRUCTURE WITH NO DANGER TO WORKMEN. *Write for catalog* *giving complete dimensional and temperature data.*

FOUNDRY COMPANY LIMA AND SPRINGFIELD, OHIO

ENGINEERS • FOUNDERS • MACHINISTS

FREE ENTERPRISE IS THE ONLY WAY TO CONSTANTLY HIGHER AMERICAN LIVING STANDARDS

Pacific

FOR HIGH EFFICIENCY PUMPING OPERATIONS

IN Pacific's 20 years of precision pump building experience, there has never been a pumping problem encountered that Pacific Pumps couldn't lick . . .and with top efficiency, too!

Every type and size of pump in Pacific's entire line is scientifically correct in design and construction. No matter what your requirements may be . . . a single pump or complete plant facilities . . . Pacific can furnish the right equipment to do the job efficiently and economically.

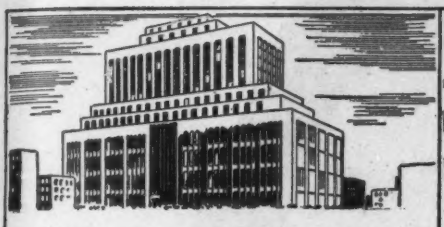
The above illustrated Pacific Type JB Centrifugal Pump is designed for boiler feed and hot water circulating systems. Available in 2 to 8 stages, sizes 1½" to 6", speeds to 3600 R.P.M., capacities to 1600 G.P.M., differential pressures to 1000 lbs., operating temperatures to 500° F. Catalog No. 80 gives full engineering data. Write for your copy!

Pacific's rigid specifications demand Impeller perfection. On this specially designed machine, sensitive to split-hair measurement and register, each Pacific Impeller is tested for dynamic balance. Result . . . smooth, vibration-free performance . . . long, efficient pump life.

PACIFIC PUMPS, INC., Huntington Park, Calif.
One of the Dresser Industries
Export Office: 30 Rockefeller Plaza, New York

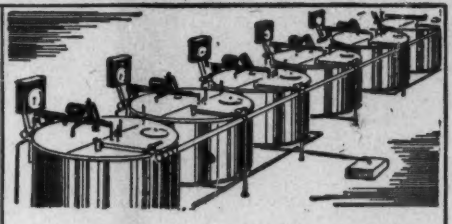
PACIFIC *Engineered* PUMPS

Stainless Steels Are Specified For These Applications:

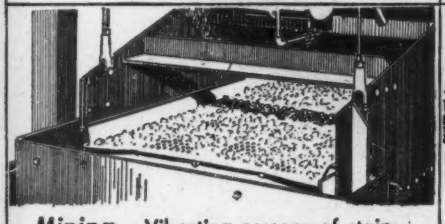


Architecture — For weatherproof exterior trim, stainless steel is not excelled in beauty or length of life.

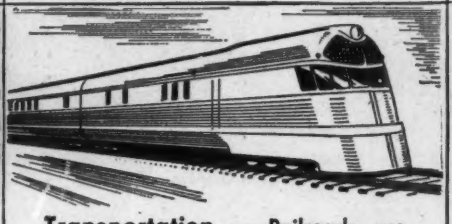
Refineries — Furnace tubes, carrying corrosive gases at high temperatures, are made of stainless steel.



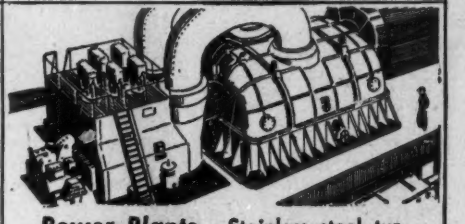
Food processors — Stainless steel milk processing equipment will not taint milk and is easily kept sanitary.



Mining — Vibrating screens of stainless steel resist abrasion and wear to give extra life.

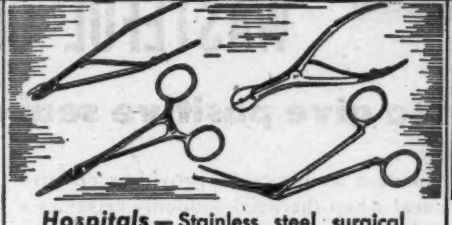


Transportation — Railroads use light-weight passenger equipment built of stainless steel.

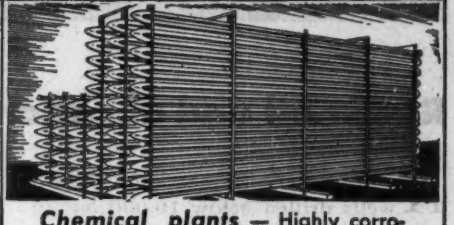


Power Plants — Stainless steel turbine blades resist corrosion and erosion of steam at high temperatures.

Textile mills — Quickly cleaned stainless steel dye vats make possible a rapid succession of dye baths.



Hospitals — Stainless steel surgical instruments resist corrosion from repeated high-temperature sterilization.



Chemical plants — Highly corrosive nitric acid is handled safely in a stainless steel condenser.

Have You Considered Using Stainless Steel?

• These are only some of the uses of stainless steel, but they may suggest how stainless steel can serve you. Although we do not make stainless steel or steel of any kind, we have had 38 years of experience in the manufacture of ferro-alloys used in the production of steel. Working closely with the steel companies and the users of stainless steel, our engineers have accumulated information on the use of stainless steel in many industries. If you want more specific details about a particular application, write to us.

BUY UNITED STATES WAR BONDS AND STAMPS

ELECTRO METALLURGICAL COMPANY
Unit of Union Carbide and Carbon Corporation
30 East 42nd Street UCC New York 17, N. Y.
In Canada: Electro Metallurgical Company of Canada, Limited, Welland, Ontario

Electromet
Trade Mark
Ferro-Alloys & Metals

The word "Electromet" is a registered trade-mark of Electro Metallurgical Company

Photo courtesy Cameron Iron Works.

Rubber parts by Murray Rubber Company.

HYCAR PACKINGS PREVENT WASTEFUL OIL WELL BLOWOUTS

Resist oil and abrasion to give positive seal against high pressures

As nearly every oil man knows, many wells drilled below 10,000 feet in recent years have depended on Cameron Blowout Preventers to eliminate the chance of costly, dangerous blowouts like the one in the picture. But it may not be so well known that the self-feeding ram packing element in the Cameron preventer is made of Hycar synthetic rubber.

There's a reason behind the selection of Hycar for this severe service. Certain properties—in just the right combination—are essential: Oil and gas resistance, to prevent deterioration and weakening of the packing; abrasion resistance, to stand 6 or 8 hours rotation of the drill pipe while weighting material is being added to the drilling mud; permanent resilience, to provide a positive seal when the need suddenly arises as a high pressure zone is penetrated.

Hycar provides these properties—*and in just the right combination.* Other properties are listed in the box at the right. That list will tell you why Hycar has so many oil field applications—gate packers in mudline valves, casing head seals, gaskets of all kinds, drilling and suction hose, and many others.

Ask for parts made of Hycar. Test them yourself in your own tough applications. Learn for yourself that Hycar can help reduce operating costs—that it's wise to use Hycar when the going gets tough. *Hycar Chemical Company, Akron 8, Ohio.*

WHAT HYCAR DOES IN OIL FIELD APPLICATIONS

1. Resists oil and gas—even under high pressure.
2. Resists action of abrasive-laden fluid under high pressure and at high velocity.
3. Wears at slow rate even under worst conditions.
4. Makes a positive, leak-proof seal, even after a long period of service.
5. Provides high elasticity.
6. Gives high tensile strength.
7. Has minimum tendency to cold flow and compression set.

Hycar

Reg. U. S. Pat. Off.

LARGEST PRIVATE PRODUCER OF BUTADIENE TYPE

Synthetic Rubber

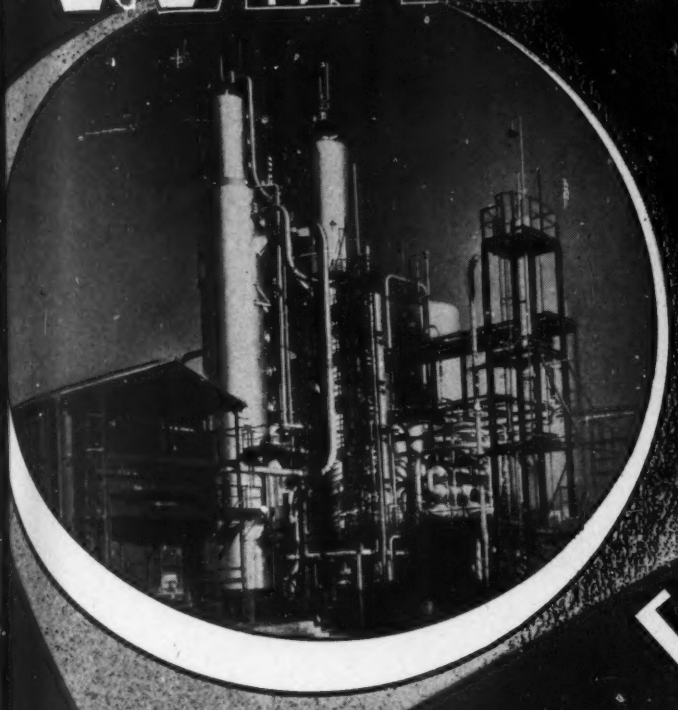
Free—write for your copy of the new pocket-size Hycar Glossary of commonly used synthetic rubber terminology.

C C

WAR TIME EXPERIENCE

NAPHTHA

POLYFORM



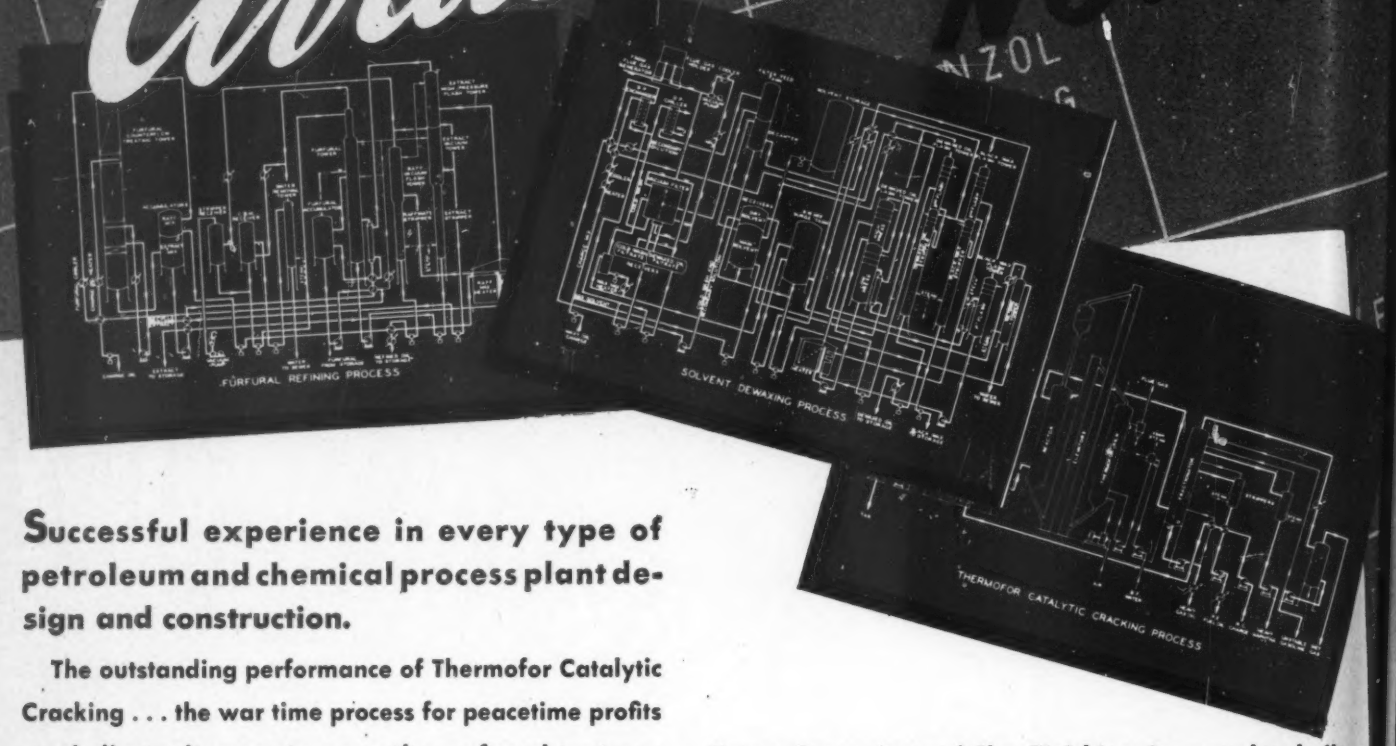
FURFURA

FOR YOUR MOVE

INTO PEACE-TIME PROFIT

D E

Available TO YOU — NOW!



Successful experience in every type of petroleum and chemical process plant design and construction.

The outstanding performance of Thermofor Catalytic Cracking . . . the war time process for peacetime profits . . . indicates its acceptance as the preferred post-war process for the economical production of high octane motor gasoline. The use of TCC synthetic bead catalyst improves the performance of TCC units beyond that of any other known catalytic operation.

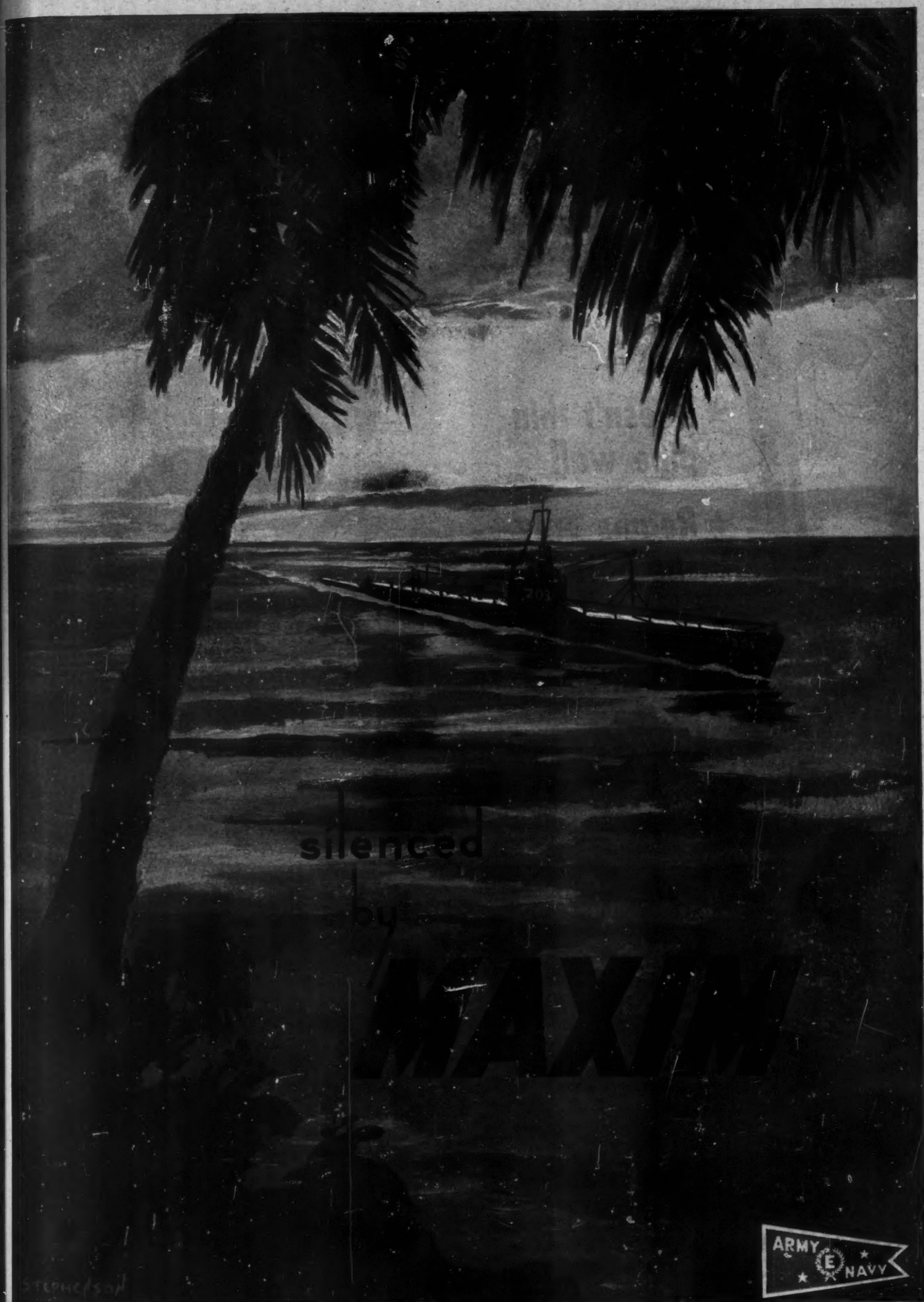
In complete refinery operation, Naphtha Polyform . . . a process that raises the octane of heavy naphtha and utilizes refinery propanes and butanes for further enhancing the yields and octane level of motor gasoline — forms an excellent team with TCC for the production of premium motor gasoline.

For high yields of high viscosity index, low pour lubricating oils, Lummus offers, as in high octane motor gasoline, a wealth of experience in Propane Deasphalting, Vacuum Distillation, Furfural Refining, Benzol-Ketone Dewaxing and Clay Finishing. Lummus has built a large proportion of the world's solvent lubricating oil refining capacity — fourteen solvent refining plants . . . nineteen solvent dewaxing units . . . including complete lubricating oil refineries.

Lummus engineering service is always available for the study of specific problems, for the modernization of existing refineries and for future planning of all types of petroleum refining and petroleum chemical plants. For further information write to: THE LUMMUS COMPANY, 420 Lexington Avenue, New York 17 . . . 600 South Michigan Avenue, Chicago 5, Illinois . . . Mellie Esperson Building, Houston 2, Texas . . . 634 S. Spring Street, Los Angeles 14, California . . . 70 Barn Hill, Wembley Park, Middlesex, England.

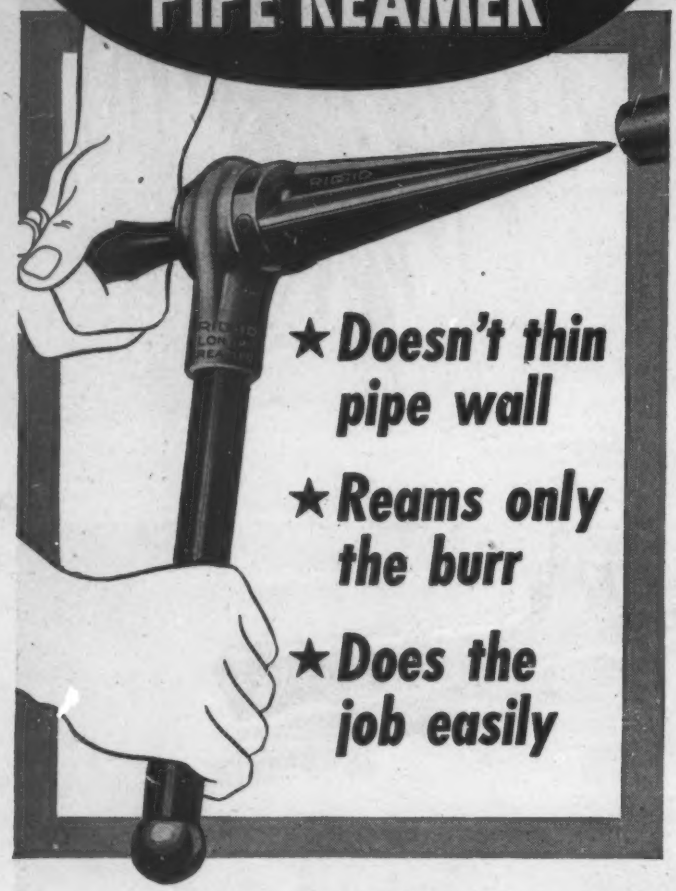
LUMMUS

PETROLEUM REFINING PLANTS



THE MAXIM SILENCER COMPANY . . HARTFORD, CONN.

RIDGID
New Extra-Long-Taper PIPE REAMER



★ Doesn't thin pipe wall

★ Reams only the burr

★ Does the job easily

● With easy feather-light ratcheted strokes of this new reamer you whisk the burr from any pipe—but *only the burr.* For the extra-long taper of this RIDGID tool keeps you from thinning pipe or conduit wall, prevents splitting or flaring. You save work—and pipe. It's complete with ratchet handle—or you may buy reamer unit only, for use in your RIDGID 00R threader handle. Try this smart reamer—at your Supply House.

PERFECT THREADS *more quickly*
on 1" to 2" pipe

RIDGID
Self-contained, Semi-automatic No. 65R

● Smooth clean precision threads on 1", 1¼", 1½" and 2" pipe—and all with the same set of 4 chasers that stay in the die stock. No changing dies, no extra dies to carry around—you set the 65R to size in a mere 10 seconds. Workholder's still quicker—turn gauge plate to size instantly—tighten only one screw. You'll like this fast easy-threading worksaver RIDGID—ask for it at your Supply House.

Workholder sets to pipe size instantly.

Dies set to pipe size in 10 seconds.

Sold by Supply Houses Everywhere

RIDGID
★ PIPE TOOLS ★

Millions of RIDGID Tools in use

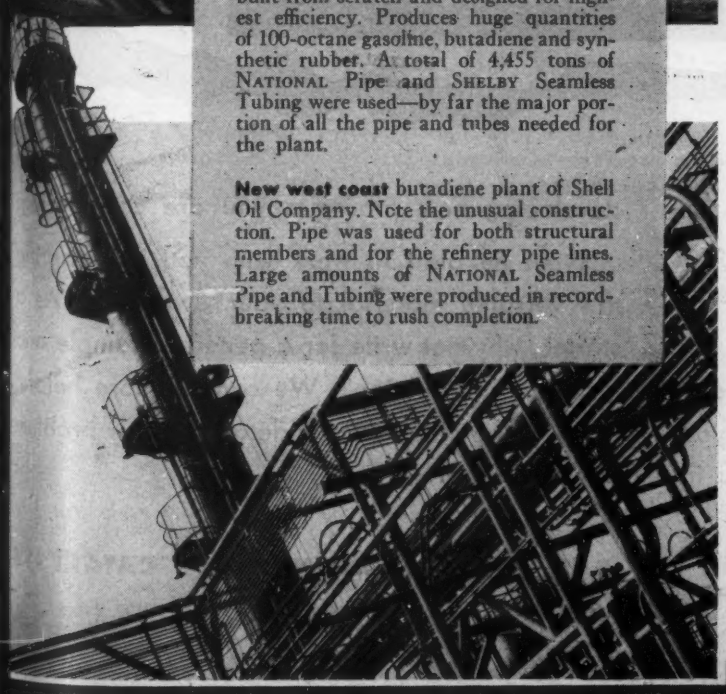
THE RIDGE TOOL COMPANY
Elyria, Ohio, U. S. A.

Gasoline Highway and Butadiene Boulevard
. . . are paved with NATIONAL SEAMLESS

Baltimore Giant they call it—this massive fluid cracking plant of the Standard Oil Company of New Jersey is one of the nation's largest producers of 100-octane aviation gasoline. It contains more than 100 miles of pipe. The major portion was supplied by National Tube Company.

Butadiene Boulevard—One-seventh of the nation's synthetic rubber needs can be supplied by this butadiene plant at Port Neches, Texas, one of the world's largest. Hundreds of tons of NATIONAL Seamless from tiny quarter-inch tubes to massive 20-inch O.D. pipe were used in its construction.

Refinery engineer's dream comes true at Lake Charles. New Cities Service plant built from scratch and designed for highest efficiency. Produces huge quantities of 100-octane gasoline, butadiene and synthetic rubber. A total of 4,455 tons of NATIONAL Pipe and SHELBY Seamless Tubing were used—by far the major portion of all the pipe and tubes needed for the plant.



New west coast butadiene plant of Shell Oil Company. Note the unusual construction. Pipe was used for both structural members and for the refinery pipe lines. Large amounts of NATIONAL Seamless Pipe and Tubing were produced in record-breaking time to rush completion.

THESE four huge refineries are among the nation's newest and largest. They are examples of the ingenuity that makes America powerful in war and in peace. They represent the very finest in engineering practice and efficiency in operation. National Tube Company is proud to have had an important part in their construction.

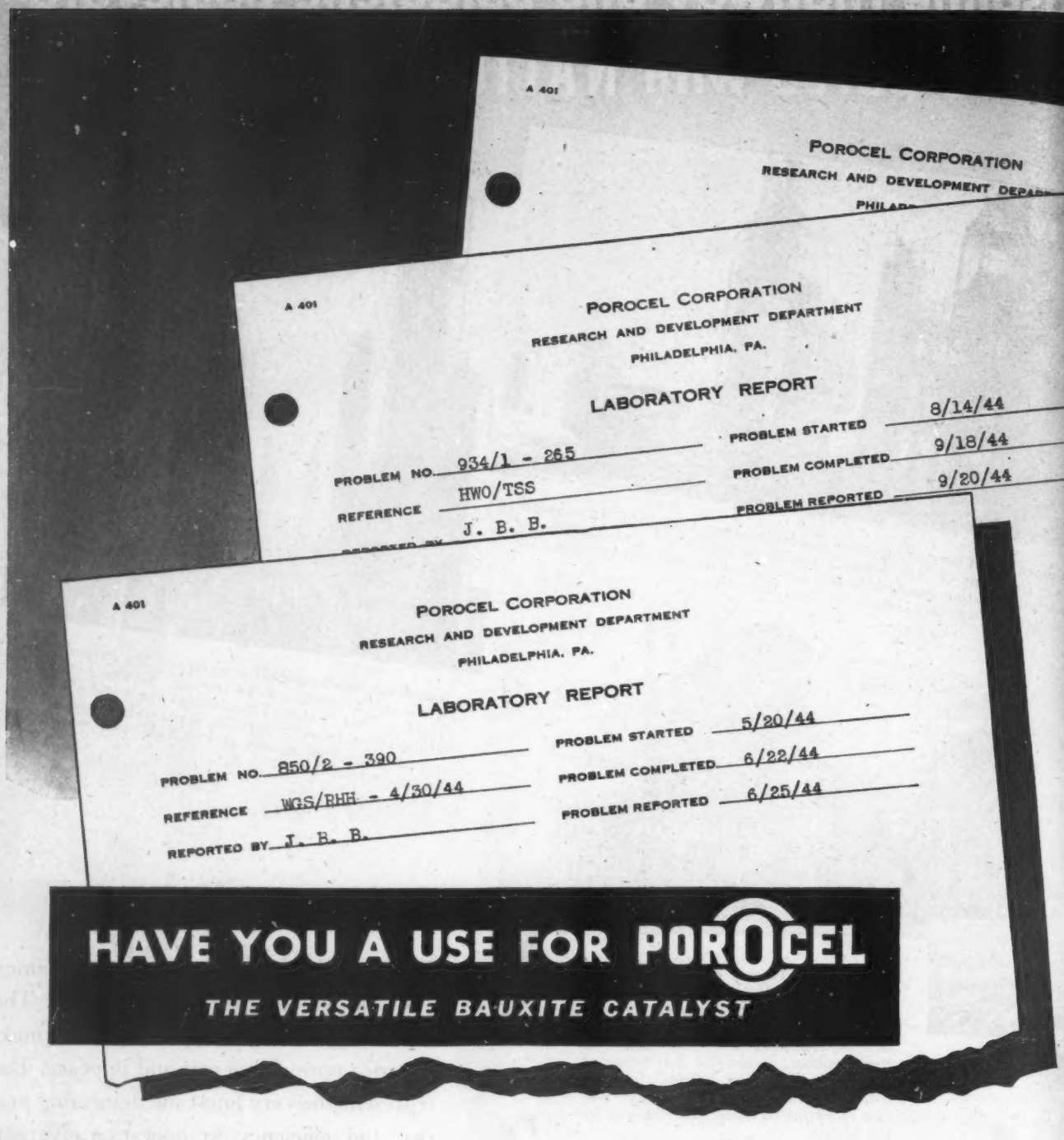
NATIONAL TUBE COMPANY

Pittsburgh, Pa.

United States Steel Export Company, New York

NATIONAL TUBE COMPANY · USS · STEEL · UNITED STATES STEEL

UNITED STATES STEEL



In the laboratories of Porocel Corporation we are finding many new uses for Porocel, the hard and granular bauxite adsorbent, catalyst, and catalyst carrier.

Perhaps one of the many applications we have studied would help you improve a process you now use. Still others may be helpful to you in developing new processes you are considering.

We'll be glad to work with you in adapting this versatile material to your own uses. As a starter, why not write for a generous sample and technical information? We can be more helpful if you will give us specific details of your problem in your letter.

POROCEL CORPORATION • BAUXITE ADSORBENTS AND CATALYSTS

260 SOUTH BROAD STREET, PHILADELPHIA 1, PA.

TO WEATHER POST WAR *UNCERTAINTY*

Naturally you want to establish yourself quickly and permanently in the post war era. To help you, Blaw-Knox offers engineering and products of wide range. It also has the facilities and personnel to manufacture for you, all or parts of your products.

One of the most important activities at Blaw-Knox is the Process Equipment Department, which among other things, specializes in the design and manufacture of equipment for the carrying out of chemical reactions by both the batch and continuous processes. This department is fully qualified to render a complete service from building pilot plants to equipment for full scale production.

Blaw-Knox leadership in the origination and fabrication of products for so many fields of industry is a ground for confidence that it can be of help to you if your business comes within the scope of its activities. Many Blaw-Knox products now of international reputation were originated to fill the needs of one manufacturer. Perhaps the Blaw-Knox umbrella of industrial coverage can include worth while services to you. May we talk it over?

A chemical plant designed, fabricated and erected by Blaw-Knox for large midwest manufacturer.

BLAW-KNOX COMPANY

2005 Farmers Bank Bldg., Pittsburgh, Pa.

Buy More War Bonds and Stamps

...MAKER FOR ...ICAN INITIATIVE ...GENUITY

...S FOUNDRY & MACHINE DIVISION, ... and Rolling Mill Machinery

...ONAL ALLOY STEEL DIVISION, ... and Corrosion-Resistant Alloy Castings

...IAL ORDNANCE DIVISION, ... Anti-Aircraft Gun Mounts and Mechanisms

PITTSBURGH ROLLS DIVISION, Rolls for Steel and Non-Ferrous Rolling Mills

POWER PIPING DIVISION, Prefabricated Piping Systems

BLAW-KNOX DIVISION, Chemical & Process Plants & Equipment, Construction Equipment, Steel Plant Equipment, Radio & Transmission Towers . . . General Industrial Products

COLUMBUS DIVISION, Ordnance Matériel

UNION STEEL CASTINGS DIVISION, Steel and Alloy Castings

MARTINS FERRY DIVISION, Bofors Anti-Aircraft Gun Mounts

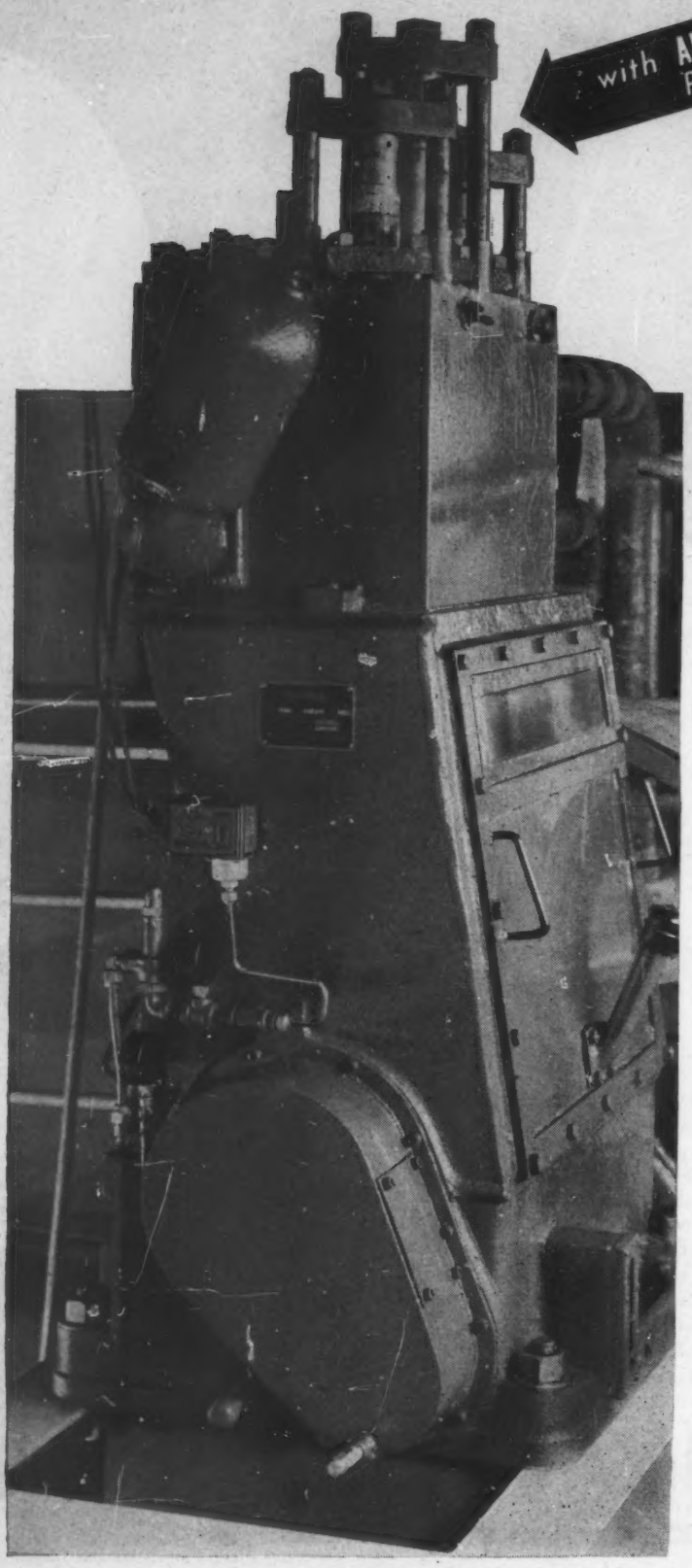
BLAW-KNOX SPRINKLER DIVISION, Automatic Sprinklers and Deluge Systems

Five Blaw-Knox Plants have been awarded the Army-Navy "E" for war-production excellence

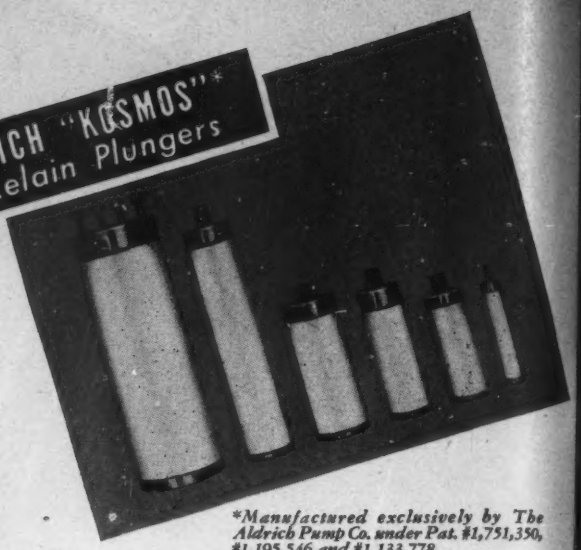
A FEW VICTORY PRODUCTS

...RAFT GUN MOUNTS · GUN SLIDES · LANDING BARGES · AERIAL BOMBS · POWDER PLANTS · PIPING FOR NAVAL VESSELS · SYNTHETIC RUBBER PLANTS
CAST ARMOR FOR TANKS & NAVAL CONSTRUCTION · CHEMICAL PLANTS

ALDRICH PUMPS...



with ALDRICH "KOSMOS"* Porcelain Plungers



*Manufactured exclusively by The Aldrich Pump Co. under Pat. #1,751,350, #1,195,546 and #1,133,778.

for... SALT WATER DISPOSAL CENTRAL HYDRAULIC SYSTEMS AND OTHER REFINERY PUMPING OPERATIONS

The combination of Aldrich pumps and "Kosmos" plungers gives long uninterrupted service on difficult pumping jobs. Leakage from stuffing boxes is held to a minimum with only finger-tight adjustment required for stuffing box gland bolts, resulting in increased mechanical and volumetric efficiency.

Properly packed "Kosmos" porcelain plungers are equivalent to a lapped fit, with the added advantage of allowing for packing adjustment when necessary. However, many Aldrich pump installations handling salt water and gritty or acidulous liquids have been in service for years with no adjustment required in original packing settings.

"Kosmos" porcelain plungers are applicable to Aldrich or any other make of reciprocating pumps. Write for Data Sheet 57-2.

"Kosmos" plungers on this 60 HP engine driven Aldrich Vertical Triplex Pump show the high saline concentration of the liquid being handled by the salt crystal deposits appearing on the plungers above the stuffing box glands.

ALDRICH

THE ALDRICH PUMP CO. ALLENTOWN, PENNA.

REPRESENTATIVES: Birmingham • Bolivar, N.Y. • Boston • Chicago • Cincinnati • Cleveland • Denver • Detroit • Duluth • Houston • Los Angeles • Pittsburgh • Portland, Ore. • St. Louis • San Francisco • Seattle • Tulsa

To **YOU** *of*
INDUSTRIAL AMERICA:

Merry Christmas *and* A Happy New Year

THE AGE-OLD WISH is repeated with the deepest sincerity by every member of the MARLEY organization . . . With earnest appreciation of the patronage which has sent us steadily to the forefront in our field, whether measured by our plants, production and experience or by the size, number and variety of Marley installations . . . With patriotic pride in the part we have been privileged to play toward speeding victory . . . With humble acknowledgment of the obligation to persevere in our program of constant improvement, that we may merit a similar place in creating a prosperous, plenteous post-war America.

MARLEY

COOLING TOWERS

ALL TYPES • ALL CAPACITIES

THE MARLEY COMPANY, INC.
KANSAS CITY 15, KANSAS

OFFICES IN MAJOR CITIES
FACTORIES: STOCKTON, CAL. & KANSAS CITY, KS.

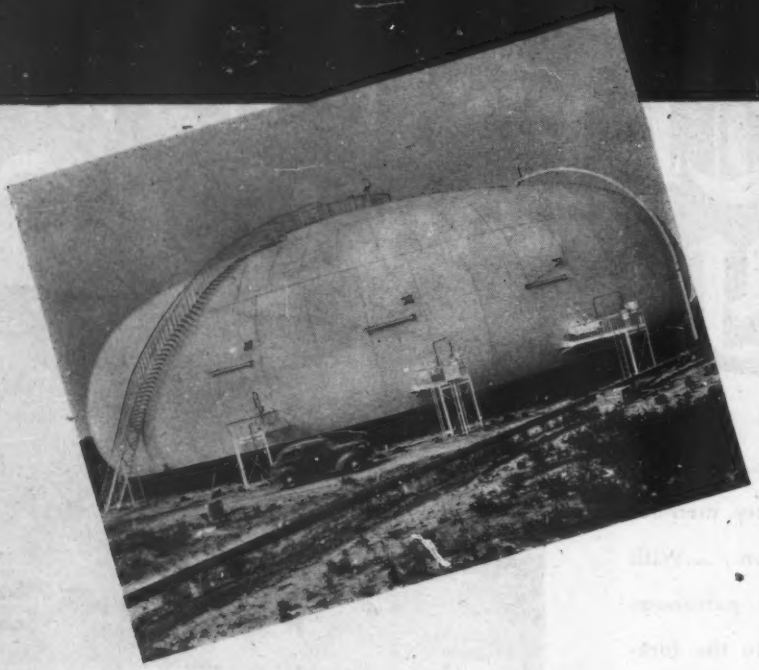


Fig. 1. Straight blade Radial Flow Turbine. Simplified shape for general agitation. Preferred for lead and rubber covering.

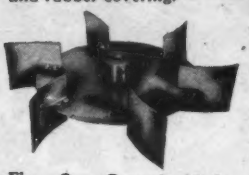


Fig. 2. Curved blade Radial Flow Turbine. Simplified form for blending and general agitation.

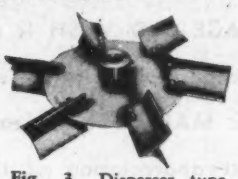


Fig. 3. Disperser type, Radial Flow Turbine for gas-liquid, liquid-liquid, solid-liquid dispersion.

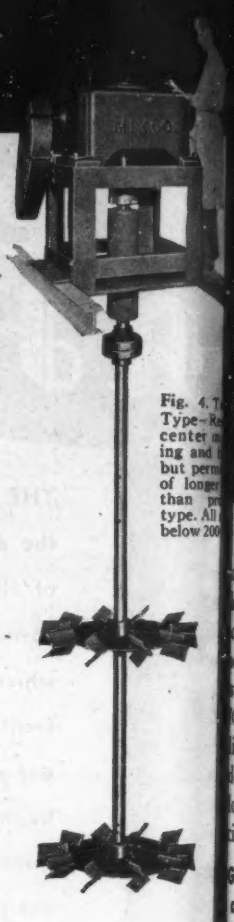


Fig. 4. T
Type—R
center
ing and
but perm
of longer
than pr
type. All
below 200

Regardless of what your liquid blending problems may be, it will repay you to consider "Process Adapted Agitation." Actual installations of Process Adapted Agitators have proved that blending time can be reduced, power consumption cut, tanker and tank car holdovers decreased and handling capacity increased in the following operations:

Gasoline Blending
Addition of Ethyl Fluid
Caustic and Doctor Treating
Boiler Feed Water Treatment
Addition of Dye
Gas Absorption
Liming Gas Oil
Lube Oil Blending
Lime Slurries
Clay Contactin
Acid Contactin
Continuous Mix

Mixing Equipment Company has 23 years of experience which has resulted in research facilities and skill which qualify it as an authority not only in mixing equipment, but in recommending the proper type of agitation to solve your particular problems. Mixing Equipment Company offers its services in the solution of any problem involving controlled recirculation of liquids to produce physical and che cal changes, and because Mixing Eq ment Company produces all type fluid agitators, you can obtain f them an impartial recommendatio the most economical solution of y problem.

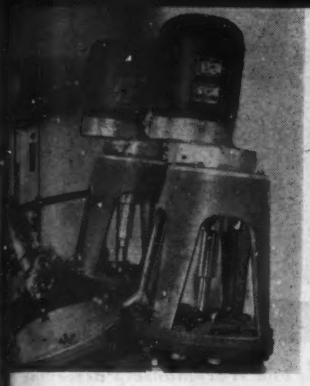
There is a process adapted agit for every shape and size of tank every operation.

EQUIPMENT THAT WILL DO THE JOB

"LIGHTNIN" SIDE-ENTERING MIXERS. These *"LIGHTNIN"* Side Entering Mixers in capacities from 1 to 25 HP are designed primarily for use in large tanks. They can be used singly batteries depending upon the si the tank, the materials to be mixed the time desired to accomplish the

MIXING EQUIPMENT CO., INC., ROCHESTER, N

Process Adapted Agitation



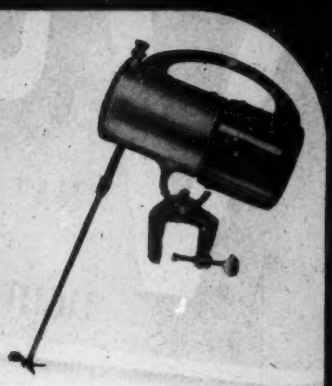
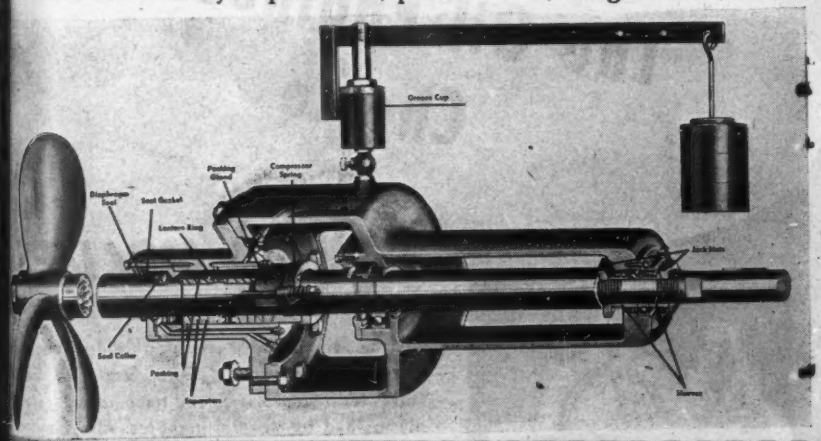


Fig. 4. T
Type–Re
center m
ing and
but perm
of longer
than pr
type. All
below 200

on. They are also suited for use in smaller s where other types of mountings are not ctical as in those cases where head room ot available or where the top of the tank t be kept clear. The adaptability of *GHTNIN"* Side Entering Agitators and the ity to do a thorough job of agitation have le mixing in tanks as large as 5,000,000 ons capacity practical, economical and ient.

GHTNIN" TOP ENTERING UNITS (*Propel- and Turbine Types*). The extended line Mixco Heavy Duty Agitators (up to 50 H.P.) open and closed tanks, find wide applica- in the newer catalytic processes, provid- ing intimate dispersion, fine particle size and high rates of recirculation within tank. This insures high yield and uniform results for properly designed systems. Newer types of impellers designed according to proven hydraulic principles, decrease weight and diameter of impellers. Improved design for using seals instead of conventional stuffing box, are optional.

"LIGHTNIN" PORTABLE TYPE MIXERS. For the Refinery, Barrel House, Specialty Department, Oil Jobber and Bulk Station; also widely used at distributing points for blending special formula oils, etc., in batches up to 5,000 gallons.



LIGHTNIN
TRADE MARK REG. U.S. PAT. OFF.
MIXCO

MIXING EQUIPMENT CO., INC.

1064 GARSON AVENUE, ROCHESTER 9, N.Y.

Please send me the literature checked:

- ☐ *B-76 Side Entering Mixers—for large Tanks*
- ☐ *B-78 Pressure Vessel Mixers continuous or batch*
- ☐ *Mi-15—Refinery Applications*
- ☐ *Mi-16—Questions and answers—gasoline blending*
- ☐ *Mi-17—Lube Oil Blending*
- ☐ *Complete Refinery Catalog Binder. For executives and engineers in authority*

Name.....

Address.....

.....

VULCAN

NATURAL GASOLINE, OIL REFINERY,
CHEMICAL PLANT,
LIGHT and HEAVY PLATE PRESSURE VESSELS

All Materials and Workmanship according to ASME or API Requirements as specified.
See REFINERY COMPOSITE CATALOG Pages 970-971

VULCAN STEEL TANK CORPORATION

TULSA, OKLAHOMA

PLANT: North Harvard & Frisco R.R. **Telephone 5-2101**

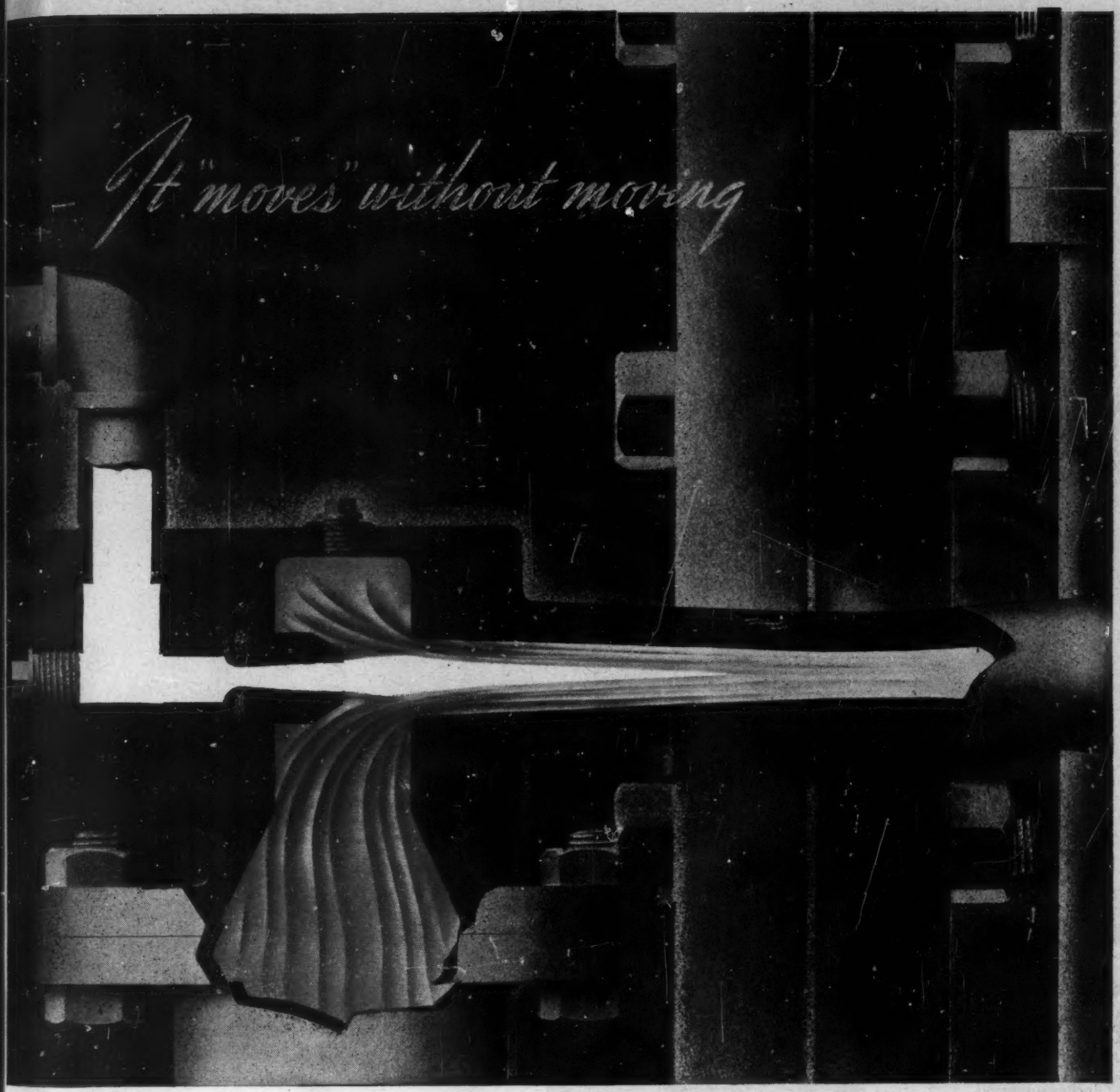
The Oil Engineer's Choice

NH VALVES

for the oil industry cover a wide range of specialized productions. Gate, Stop and Check Valves for high pressures and temperatures, steam, oil, gas and for general purposes. Also Newman-Milliken Glandless Lubricated Plug Valves for all oilfield and refinery services. Working pressures to 5,000 lbs. per square inch (tested to 10,000 lbs. per square inch Kerosene). Made in various metals to suit particular services.

Newman, Hender & Co. Ltd

WOODCHESTER NH GLOS. ENGLAND



This pump, having *no* moving parts, is so fundamentally simple and trouble-free that it takes but little imagination to appreciate its advantages. Such pumps, which operate on the jet principle, have long been used to lift and transfer liquids and solids; to produce vacuum or pressure; to condense vapors; to mix gases; to heat and agitate liquids . . . and for many other purposes. They not only perform economically, but their simplicity assures continuous, trouble-free operation.

Where can you apply this time-tested, dependable jet principle to improve your process or to reduce the cost of your product? The research and engineering facilities of Schutte & Koerting, who have pioneered the application and development of jet pumps of all types since 1876, are available for consultation on your specific problems.

STEAM JET	LIQUID JET	AIR JET
Agitators	Agitators	Agitators
Compressors	Condensers	Compressors
Ejectors	Compressors	Ejectors
Exhausters	Exhausters	Exhausters
Heaters	Mixers	
Vacuum Boosters		

. . . both SINGLE- and MULTI-STAGE

Write today for Condensed Catalog J-2 which outlines many of the countless industrial applications of the jet principle.

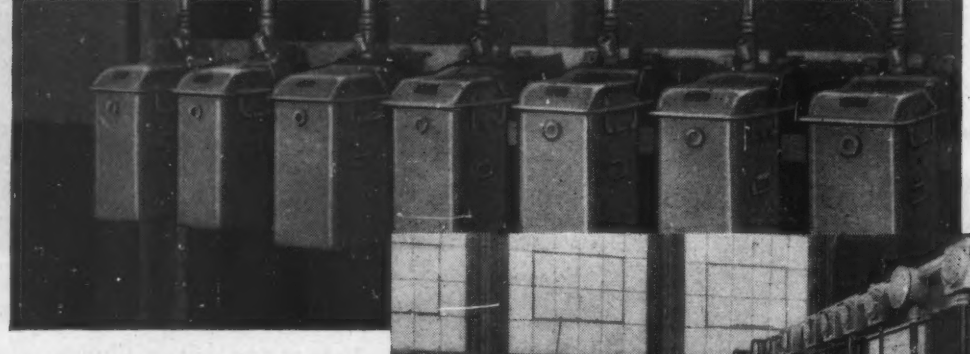
SCHUTTE & KOERTING CO.

MANUFACTURING ENGINEERS

1174 THOMPSON STREET

PHILADELPHIA 22, PENNSYLVANIA

Eight G-E totally enclosed, fan-cooled induction motors driving centrifugal pumps outdoors at a natural-gasoline plant. Squirrel-cage motors of this type are available in ratings up to 1000 hp, listed by Underwriters' Laboratories, Inc., for Class I, Group D, conditions.



Arriving ready for installation in Class I, Group D, location, rack assembly of G-E oil-immersed 440-volt combination starters. Suitable for motors up to 100 hp, these starters operate with all contacts at least six inches under oil.

Eleven G-E combination air-break starters for Class I, Group D, hazards controlling G-E explosion-proof pump motors in a gas-cycling and repressuring plant.

MOTORS AND CONTROL

for Hazardous Areas

a Housing Problem
IN HAZARDOUS AREAS

xplosion-proof motors and suit-ble control eliminate the need for pecial isolation to meet haz-rds—both explosion and corrosion.

UILDING separate vaults or housings to isolate electric equipment from explosive and corrosive mospheres is costly. It wastes engineering and in-allation time. It complicates maintenance. So do mbersome remote-drive arrangements.

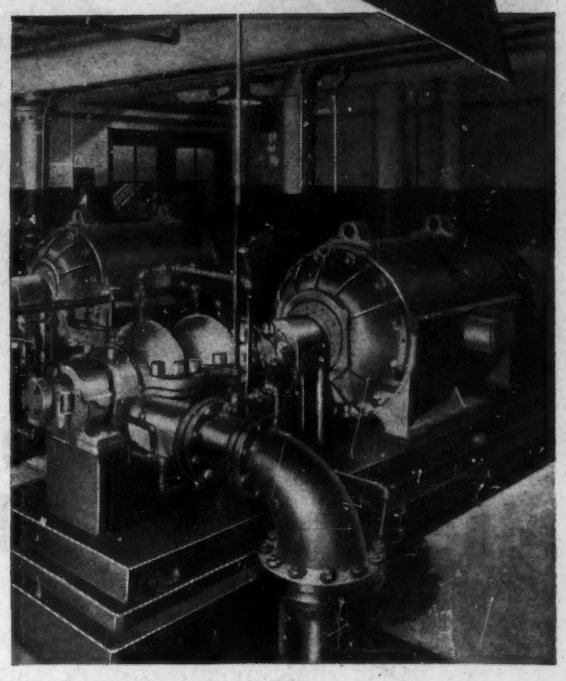
G.E. builds motors and control that are specially signed to be "put on the spot" in Class I, Group D, cations—*without* any extra safeguards. They carry eir own protection. They are "at home" indoors or t in the open. You locate them solely on the basis convenience, and economy of space and machinery.

NAME YOUR HAZARD

Whether it's high-octane gasoline, toluene, natural as, acid fumes, or outdoor service, there's a way to eet your conditions with a combination of G-E motors nd control. For General Electric builds the most com-lete line of motors and control devices for use in Class as well as Class II locations.

And—assistance in selecting the motors and control hich best combine security and economy on your jobs right within reach of your telephone. G-E engineers pecializing in refinery applications will be glad to ave you call on them via the G-E office near you.

UY ALL THE BONDS YOU CAN—*AND KEEP ALL YOU BUY*



Two 250-hp, 3000-rpm G-E explosion-proof, squirrel-cage induction motors powering cold-crude-oil charging pumps. G-E wound-rotor and solid- and hollow-shaft vertical motors are also available in explosion-proof construction.

To General Electric Company, Section E654-30 Schenectady 5, N. Y.

Sure *I'd like to have a copy of your helpful new 24-page bulletin, "Motors and Control for Hazardous Locations," (GEA-4131)*

Name.....

Company.....

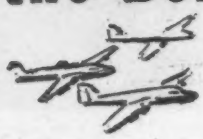
Address.....

City.....State.....

GENERAL ELECTRIC

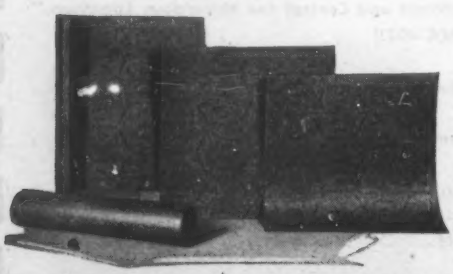
654-30-152

Garlock Helps Fuel the Bombers to Blast the Axis



Our big, 4-engined bombers with their loads of block-busters use tons of gas on every mission. The dependable performance of GARLOCK packings, gaskets and KLOZURE oil seals in the production, refining and transportation of petroleum products, helps keep our planes supplied with fuel.

THE GARLOCK PACKING COMPANY
PALMYRA, NEW YORK
Tulsa, Okla. Houston, Tex.
Los Angeles, Calif.



GARLOCK 7021 Compressed Asbestos Sheet Packing is a superior gasketing material for severe conditions, such as superheated steam at extreme pressures and light oils at high temperatures. Thicknesses $\frac{1}{16}$" to $\frac{1}{4}$". Sheets 40" x 40" and larger.

GARLOCK

Castings that Rival Forged Steel

DURASPUN High Alloy Centrifugal Castings approach forged steel in tensile strength, have metal structure free from casting faults, and offer amazing dimensional accuracy. And the alloying elements, chromium and nickel, give a resistance to corrosion, abrasion, and temperature that forged steel cannot match.

Tubes, shells, jackets . . . almost any cylindrical shape can be cast centrifugally from high alloy metals by the DURASPUN method. The one requisite is a "circular" hole, extending through the length of the piece. In regular tubing, the walls are uniform in thickness, with true outer and inner concentricity. Irregular shapes may be cast, with smooth walls or with grooves, flanges, cleats, splines, etc.

Individual castings range up to 8000 pounds in weight. Metal analyses are selected to suit your needs. Our experienced metallurgists will be glad to advise you in any way desired.

THE DURALOY COMPANY

Office and Plant: SCOTTDALE, PA.
Eastern Office: 12 East 41st St., New York 17, N. Y.

Los Angeles & San Francisco: Kilsby & Graham
Chicago & Detroit: F. B. Cornell & Associates

Metal Goods Corp.: St. Louis - Houston - Dallas - Tulsa - New Orleans - Kansas City

What outdoor exposure does to low-purity aluminum pigments

More graphically than words, this photograph tells the facts . . . facts vitally important to maintenance men in the oil industry.

These five test panels were painted with aluminum paints that were identical in every respect except the purity of the metal from which the pigment was made. Flake size was the same. Vehicle the same.

Panel No. 1225 was painted with Standard Alcoa Albron Paste No. 205, made from 99+% pure aluminum. Panel No. 1226, with pigment made from 95% aluminum. Panel No. 1227, from 91% aluminum. Panel No. 1228, from 90% aluminum. Panel No. 1229, from 87% aluminum.

You see what happened after 25 months exposure at New Kensington, Pa., Panel No. 1225, painted with Standard Alcoa Albron, retained excellent color and showed no failure. All of the panels painted with low-grade aluminum pigments darkened and rusted. Those painted with the pigments made of the two lowest purity metals were covered with rust over almost the entire surface, as shown by the dark areas in the photograph.

Clear proof, this, that high-grade aluminum is vitally important for making good aluminum pigment that will stand exposure to the weather.

WARNING! Know the purity of the pigment you get! This is vital for long-lasting protection of storage tanks and other steel equipment. You can be sure the pigment is made of 99+% pure aluminum if it is Alcoa Albron, made by ALUMINUM COMPANY OF AMERICA, 1950 Gulf Building, Pittsburgh 19, Pennsylvania.

7 ADVANTAGES OF ALUMINUM PAINT

- High durability
- High reflectivity
- High hiding power
- Resistance to moisture
- Resistance to fumes
- Resistance to heat
- Attractive appearance

ALCOA

ALBRON Pigments for ALUMINUM PAINT

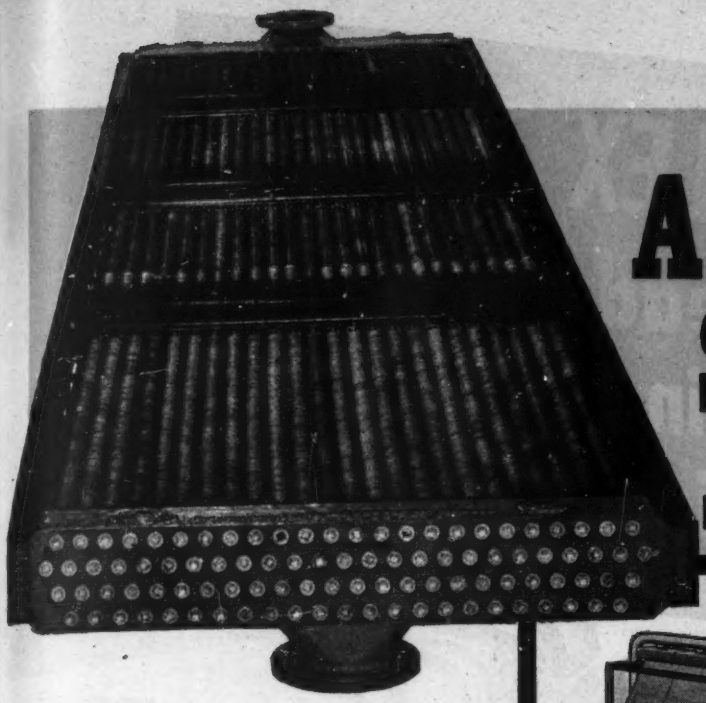
MADE UNDER PATENTS OF METALS DISINTEGRATING COMPANY, INC.

AO Safety Goggles are your insurance against expensive eye accidents. For unless you have adequate protection against every eye hazard in your plant, you're going to furnish an eye patch for an injured man sooner or later. The patch won't cost much in itself—but doctor's bills, lost production and spoilage can easily run the cost of one eye injury to well over $1,000.

For about 75c per eye—the average cost of AO Safety Goggles—you provide maximum eye protection for each skilled worker and you eliminate expensive eye accidents which run up production costs.

Call in an AO Safety Representative—and keep your "production eyes" producing.

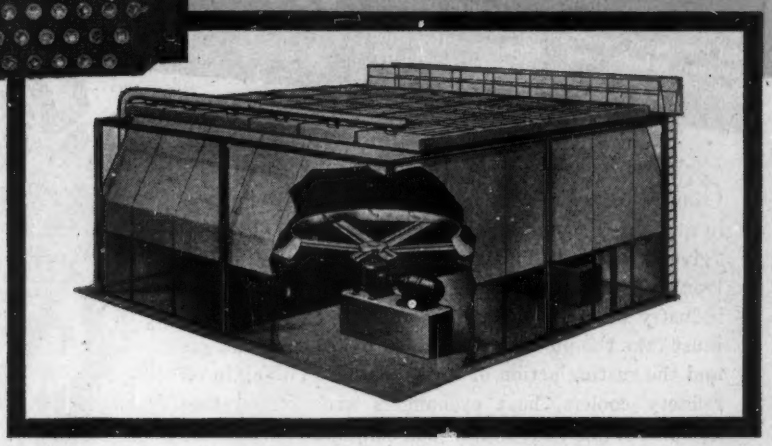
American Optical
COMPANY
SOUTHBRIDGE, MASSACHUSETTS



K-FIN AIR-COOLED SECTIONS

are incorporated in the

FIN-FAN HEAT EXCHANGER



Portion of K-Fin tubing. This finned tubing has also proven its effectiveness and durability in shell-and-tube type vapor condensers involving cooling of non-condensibles, gas-to-liquid heat exchangers including steam generating elements, and reboilers.

In the Fin-Fan Heat Exchanger, a joint development of The Fluor Corp., Ltd. and The Griscom-Russell Co., fluid cooling and condensing services are accomplished by G-R K-FIN SECTIONS utilizing Fan-circulated atmospheric air as the coolant. This represents the most recent application of G-R K-FIN ELEMENTS, the patented Helically-Finned Tube developed over fifteen years ago, and used in many thousands of units for heating and cooling air and other gases.

Note the provision in the headers for accessibility to the tube interiors plus the fully demountable supports employed, both distinctive features permitting internal cleaning and replacement of individual elements.

Write for complete information on these standard, interchangeable condensing and cooling sections, and on the Fin-Fan Heat Exchanger.

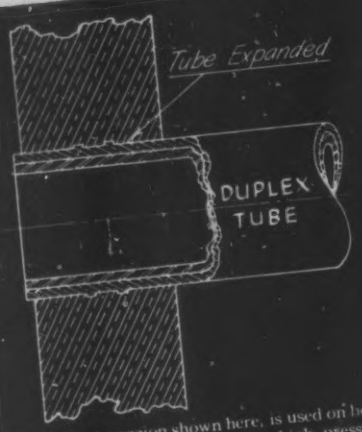
THE GRISCOM-RUSSELL CO.

285 Madison Avenue New York 17, N. Y.

GRISCOM-RUSSELL

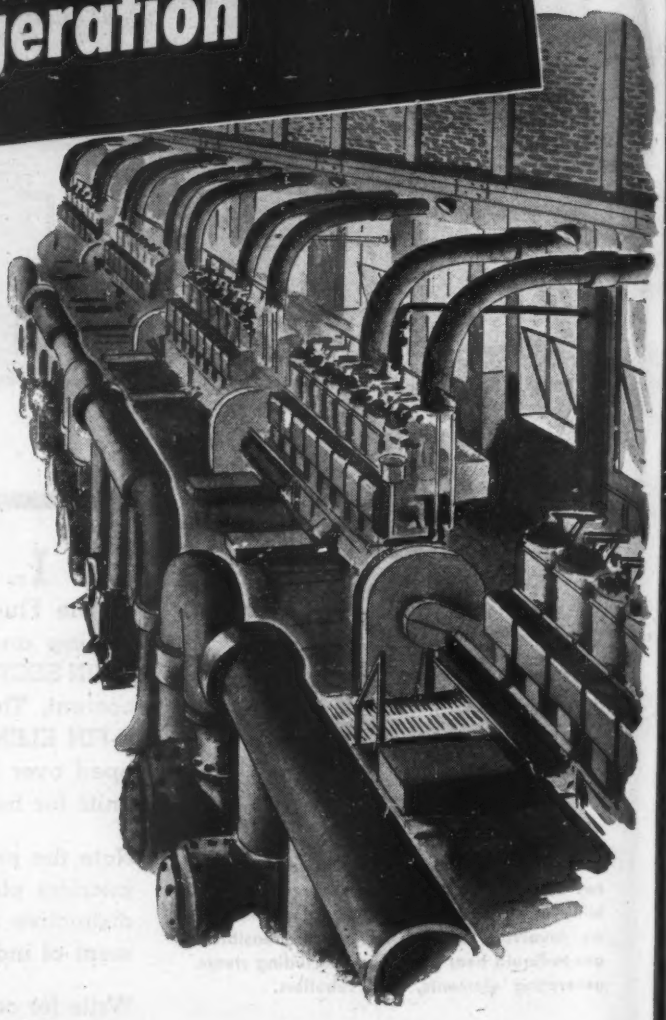
Pioneers in Heat Transfer Apparatus

Illustration showing one method of installing Duplex Tubing, reproduced from Bridgeport's Technical Bulletin.



The plain expansion shown here, is used on both the inlet and outlet ends where high pressure and low liquid velocities through the tube are involved, as in the case of ammonia refrigeration systems, or in the coke by-products industry.

DUPLEX TUBING ...leads a Double Life in Oil Refinery Refrigeration



Giant coolers and ammonia refrigeration installations in modern oil refineries demand tubing with plenty of "give and take." This tubing must give continuous, trouble-free, volume production to help the petroleum industry satisfy the voracious appetite of war. And it must take the punishing effects of moist ammonia gas and the rusting action of water. Duplex Tubing in oil refinery coolers, heat exchangers and refrigerating equipment must withstand such combinations as brine and oil, ammonia vapor and brine, and oil and water. Admiralty, Cupro Nickel, DURONZE IV or Copper, combined with steel is generally used.

Chemical and pharmaceutical plants are interested in Duplex Tubing composed of copper with aluminum for formaldehyde condensers; copper with steel for ammonia liquor coolers; copper and steel for heater coils in hot brine, etc. Other processes and industries require combinations of Cupro Nickel, DURONZE IV, Cuzinal or Red Brass with low carbon steel, Stainless or Monel metal, designed to resist specific severe corrosion.

Your nearest Bridgeport technical advisor will be glad to help you solve difficult corrosion problems involving tubing. In the meantime, write for Bridgeport's technical bulletin, describing practical applications and methods of installing Duplex Tubing.

BRIDGEPORT

Condenser and Heat Exchanger Tubing

A PRODUCT OF

"Bridgeport" **BRIDGEPORT BRASS COMPANY**

BRIDGEPORT 2, CONN. Established 1865

Throughout the history of explosives chemistry, the name of Alfred Bernard Nobel stands out above all others. Not only the inventor of dynamite and many other modern explosives, but the first to produce nitroglycerine commercially, this Swedish genius radically advanced both the science and utility of explosives.

IN INSTRUMENTATION IT'S FOXBORO!

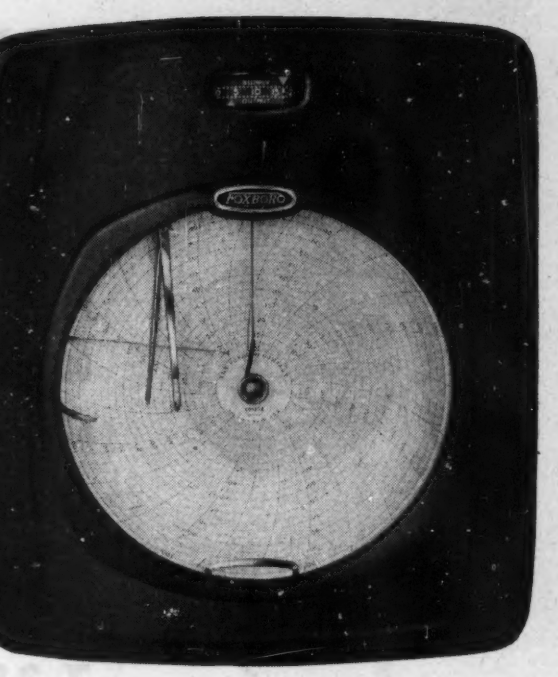
Many major advances such as the STABILOG CONTROLLER with HYPER-RESET have made Foxboro the outstanding name in process instrumentation.

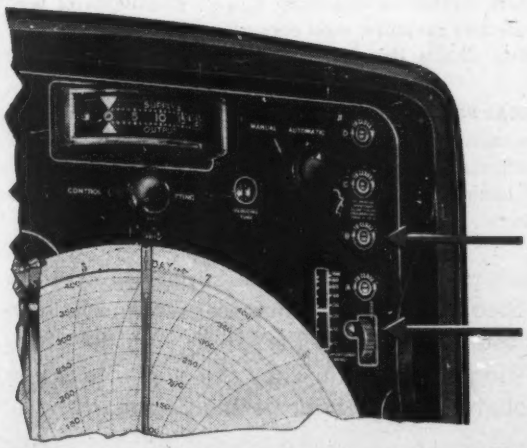
During 30 years of specialized research and application engineering, Foxboro has contributed more to the world's knowledge of process control, and has originated more of the important advances in instrumentation, than any other instrument company.

What this engineering leadership means to industry is clearly illustrated by the new degree of unit process control stability made possible by Foxboro's Stabilog Controller with HYPER-RESET.

Operating on an exclusive Foxboro rate-sensing principle, this revolutionary instrument provides both automatic reset and selective derivative action. It literally "feels" the rate of disturbance-change the moment it starts, and applies corrective action of the precise magnitude required. Recovery is often effected in as little as ¼ the usual time with up to 50% reduction in the amount of upset!

Illustrated Bulletin A330 contains detailed information about HYPER-RESET Stabilog Control. For your copy, write The Foxboro Co., 74 Neponset Ave., Foxboro, Mass., U. S. A.





THE ONLY DERIVATIVE-ACTION RESET CONTROLLER REQUIRING JUST 2 ADJUSTMENTS!

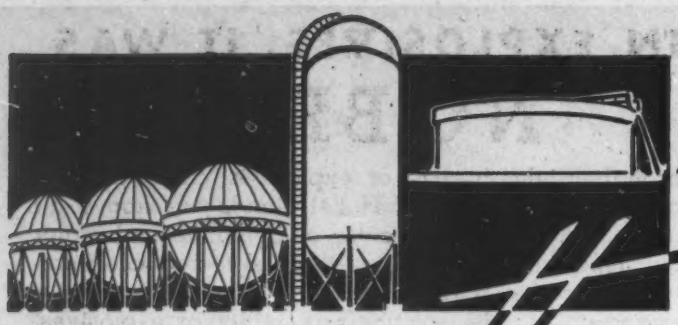
Foxboro's Hyper-Reset Stabilog Controller simplifies normal adjustment by combining reset and rate-sensitive functions. Hence, just 2 adjustments speedily give optimum unit process control.

1. **Hyper-Reset** combines reset and rate-sensitive functions. One adjustment establishes both settings. The versatility of this combined function is such that its adjustment is not critical.

2. **Proportional Band** is adjusted between zero and 100 per cent simply by turning a knurled knob. A lock screw protects against any later unauthorized changes in adjustment.

FOXBORO Stabilog Control

REG. U.S. PAT. OFF.



These

PITTSBURGH •DES MOINES

RESEARCH STUDIES AND REPORTS SHOULD BE IN THE REFERENCE FILES OF EVERY PROCESSING ENGINEER AND DESIGN EXECUTIVE CONCERNED WITH SYNTHETIC RUBBER

7.401-B **THE STORAGE OF ISOBUTYLENE.** A 36-page report on the subject, including variables which affect storage costs; storage container recommendations; cost data; charts, drawings; corrosive effects; deterioration in storage; transportation, etc.

7.381-C **(Second Edition)** **THE STORAGE OF 1:3 BUTADIENE.** Includes sections on chemical and physical properties of the substance; container materials; protective coatings; storage conditions of temperature and pressure; most economical storage plant type; cost data, charts, drawings, etc. 36 pages.

7.427-B **PHYSICAL PROPERTIES.** Pertinent to the Storage of a Number of Commercially Important Liquids and Gases. A valuable tabulation of data on 91 substances, of assistance to technicians, chemists, and engineers engaged in providing storage facilities.

These reports have been compiled under the supervision of the Pittsburgh-Des Moines Steel Company's Chemical Storage Fellowship at the Mellon Institute of Industrial Research, with the collaboration of our engineering department. They are available to you upon request, without charge, as a service of this Company.

PITTSBURGH • DES MOINES STEEL CO.

PITTSBURGH, PA., 3470 NEVILLE ISLAND
DES MOINES, IOWA, 971 TUTTLE STREET

New York, Rm. 921, 251 Broadway · Chicago, 1274 First National Bk. Bldg.
Dallas, 1275 Praetorian Building · San Francisco, 677 Rialto Building
Seattle, 578 Eighth Avenue, South

New

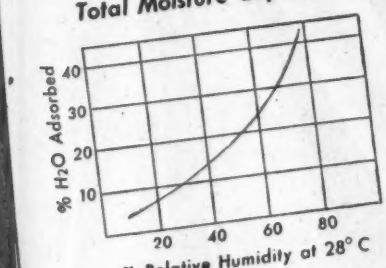
Westvaco CHEMICALS

GRANULAR MAGNESOL

NEW DESICCATING DECOLORIZING AGENTS

DESICCANT GRADE

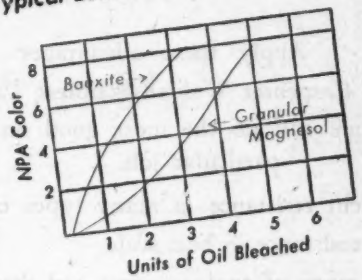
Total Moisture Capacity



Breakpoint capacity at 35% RH—7.5%.
Easily regenerated at 200-250° C.
Rapid in its adsorption of water.
Will not become wet on exhaustion.
Will not shrink, expand or disintegrate on adsorption of water.

PERCOLANT GRADE

Typical Lube Oil Bleaching Curve



Bulk density of 30-60 mesh—0.55g/cc.
Passes AN-O-S—366 hardness test.
Can be repeatedly regenerated to a high efficiency by the use of a selective solvent.

GENERAL PROPERTIES

Insoluble in water and organic liquids.
pH of 7.5 in 5% water slurry.
Will be available in large quantities and in various granulations at low cost.
Synthetic granular Magnesium Silicate, having a high affinity for polar compounds and possessing many unique characteristics indicated by the data shown, may have applications in your products or processes. It may also have potential application as a catalyst and catalyst supporting agent.

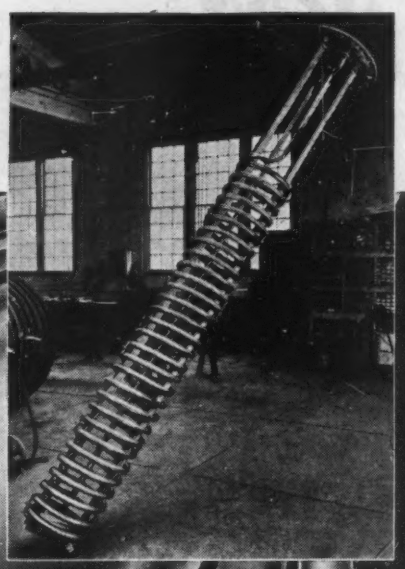
Sample quantities are now available for your examination. Write, wire or phone Technical Service and Market Development Division.

WESTVACO CHLORINE PRODUCTS CORPORATION
405 LEXINGTON AVENUE • NEW YORK 17, N. Y.
CHICAGO, ILL. • GREENVILLE, S. C. • NEWARK, CALIF.

There's More to Stainless Tubing Than Analysis

As far as analysis goes, two pieces of stainless tubing, both Type 302 for example, are alike. But there the likeness stops. Beyond that plus values take over—plus values resulting from long experience such as accumulated by Carpenter as a pioneer in the development of Welded Stainless Tubing. From the beginning we have worked closely with engineers—learning their problems to which we applied our working knowledge to help improve processes and products. This "know how" is yours for the asking. We'll be glad to help whenever you run up against trouble in selecting or fabricating corrosion and heat resistant material.

For this heating coil used in a chemical process, Carpenter Welded Stainless Tubing met three requirements of 1) coiling light walls on close radii, 2) resistance to corrosion, and 3) availability from stock.



Apply these advantages of Carpenter Welded Stainless Tubing where they will do the most good on your particular job.

- Excellent resistance to many types of corrosion
- High resistance to heat scale
- Wide range of analyses, sizes and shapes
- Uniform tube walls — no thin spots
- Easy to bend, expand, weld, etc.
- Extra strength, light weight
- Each length 100% hydrostatically tested
- Meet Army-Navy Specifications
- Cold-rolled surface quality, inside and out
- Lower fabricating cost
- Readily available from distributors' warehouse stocks

Carpenter
WELDED STAINLESS TUBING

Send for This Handy File Folder containing helpful information on types of analyses, physical properties, sizes, gauges, shapes. Just drop us a note on your company letterhead.

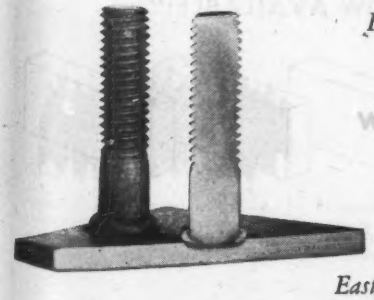
THE CARPENTER STEEL CO.
WELDED ALLOY TUBE DIVISION
KENILWORTH, N. J.

Complete fusion of stud to metal in less than 1/2 second...

The Nelson Stud Welder is simple to operate because the welding is *automatically* controlled. It eliminates the need for drilling, tapping, and hand welding bolts to secure parts, because it end-welds studs directly to the metal surface.

It is used by more than 460 industrial plants and shipyards. Operators are securing 500 to 1500 studs a shift. No previous welding experience is necessary to operate it.

Complete fusion of the stud to metal is obtained by accurate arc timing control, automatic action of the "gun," the use of flux-filled studs, and complete shielding of the arc.



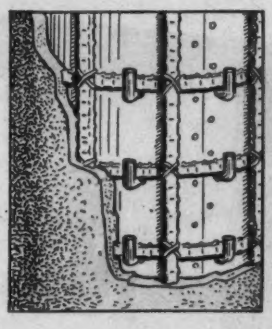
Cutaway view of stud, after etching with Nital.

For complete data, catalog and price list, write:

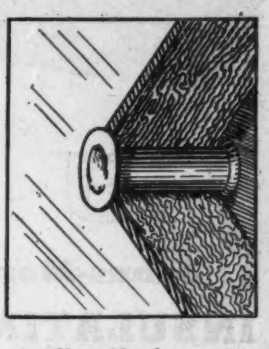
NELSON SPECIALTY
WELDING EQUIPMENT CORPORATION
Dept. 43, 440 Peralta Avenue
San Leandro, California

Eastern Representative: Camden Stud Welding Corp. Dept. 22, 1416 South Sixth St., Camden, N. J.

TYPICAL STUD APPLICATIONS



Reinforcing Cement – Where sprayed-on cement is used to cover tanks, vats, stacks, etc., studs are used to secure reinforcing wire. Studs may be welded straight and bent to desired position, or welded bent.

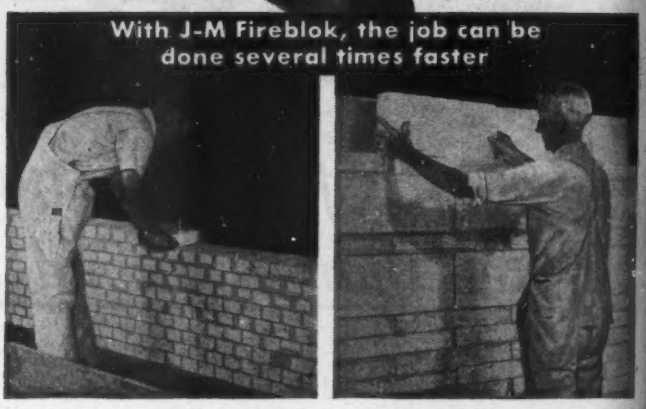


Securing Sheet Metal – Sheet metal to protect soft insulation material is secured with female studs and drive-screws. Studs are welded at 12" centers and insulation impaled over them. Metal covering placed over and secured by tapping screws into studs.

Lagging Studs — Secure magnesia blocks for insulation purposes. The stud is welded, and wire slipped through the hole. The blocks are then placed under the wire and the wire pulled tight. Plaster covering is then installed over lagged area.

NELSON STUD WELDERS & STUDS

NEW TIME-SAVING REFRACTORY LINING



Johns-Manville presents
INSULATING FIREBLOK
to make possible faster, more efficient installations

THESE FOUR new light-weight J-M Insulating Refractory Linings are suitable for the same service conditions and range of temperatures as the four well-known J-M Insulating Fire Brick. The only difference is in size . . . a single Fireblok covers more surface than five full-size brick.

The large, convenient size of Fireblok provides many advantages. The greatest, perhaps, is the reduction in installation time, minimizing down time and consequent loss of production. On most jobs Fireblok linings can be installed in considerably less time than is required for standard size brick. The many hours thus saved help to keep production schedules at their peak. Fireblok has these important features, too:

Easy cutting and fitting—J-M Fireblok can be easily cut with a saw and shaped with a rasp. Most special shapes can be either shop or field cut from standard slabs, reducing the inventory of special shapes.

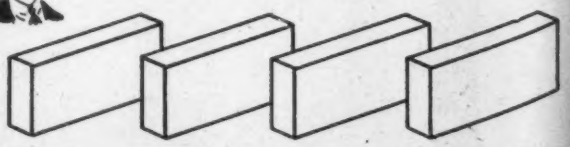
Minimum of Joints—the large size, compared to the standard fire brick unit, materially reduces the number and length of joints, resulting in a thermally more efficient construction.

Economical Bonding—with reduced joint length Fireblok requires a minimum of air-set cement for bonding. (J-M 1626 Cement was especially developed for this use.)

Uses—Fireblok can be used wherever Insulating Fire Brick are recommended, such as for oil heaters, pipe stills, flues, stacks and similar equipment. Also for the lining of doors, suspended arches, and, when tapered, for sprung arches of exceptional stability.

Write for new booklet, IN-103A, on this J-M development. Johns-Manville, 22 East 40th Street, New York 16, New York

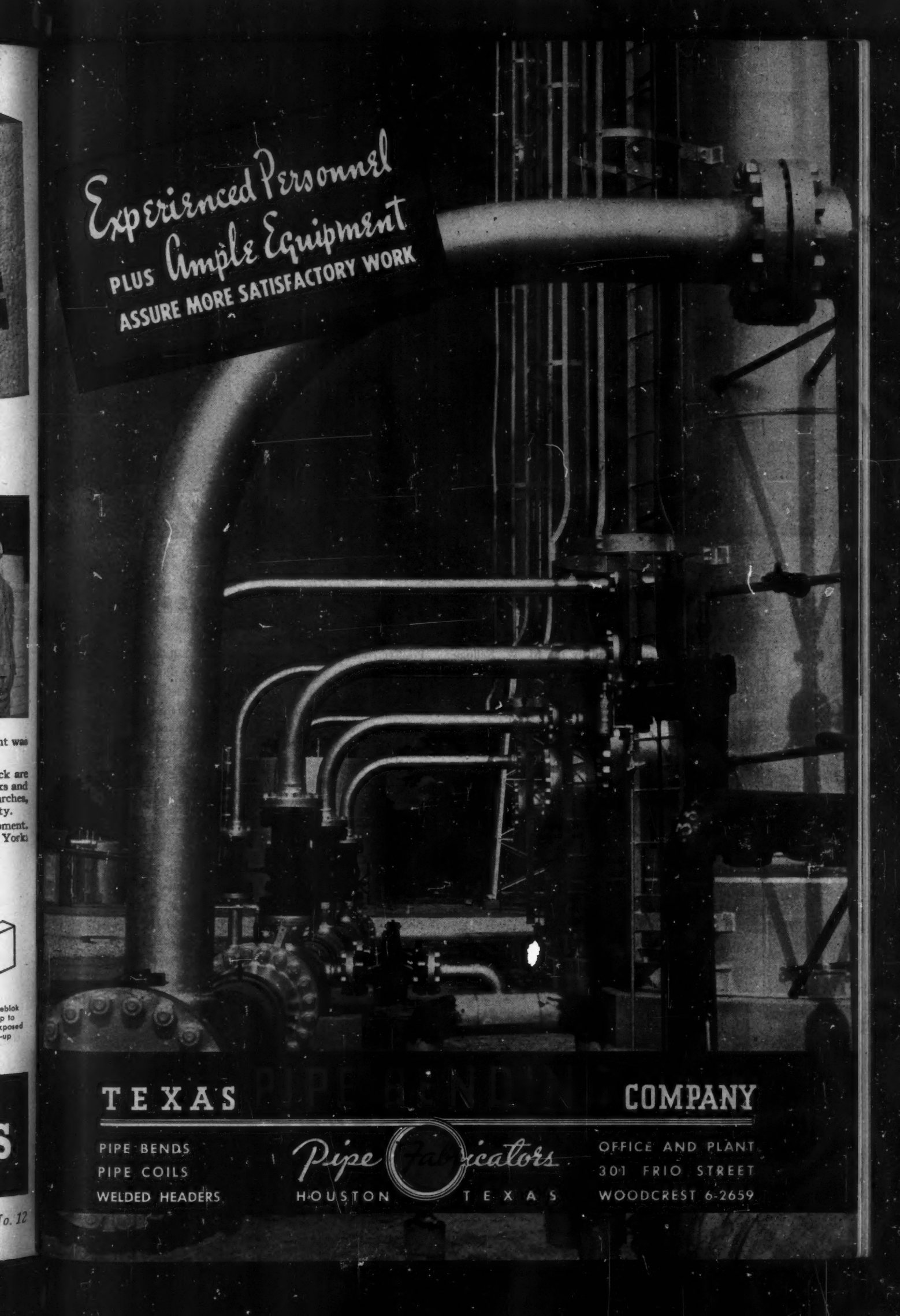
"J-M INSULATING FIREBLOK ARE NOW AVAILABLE!"

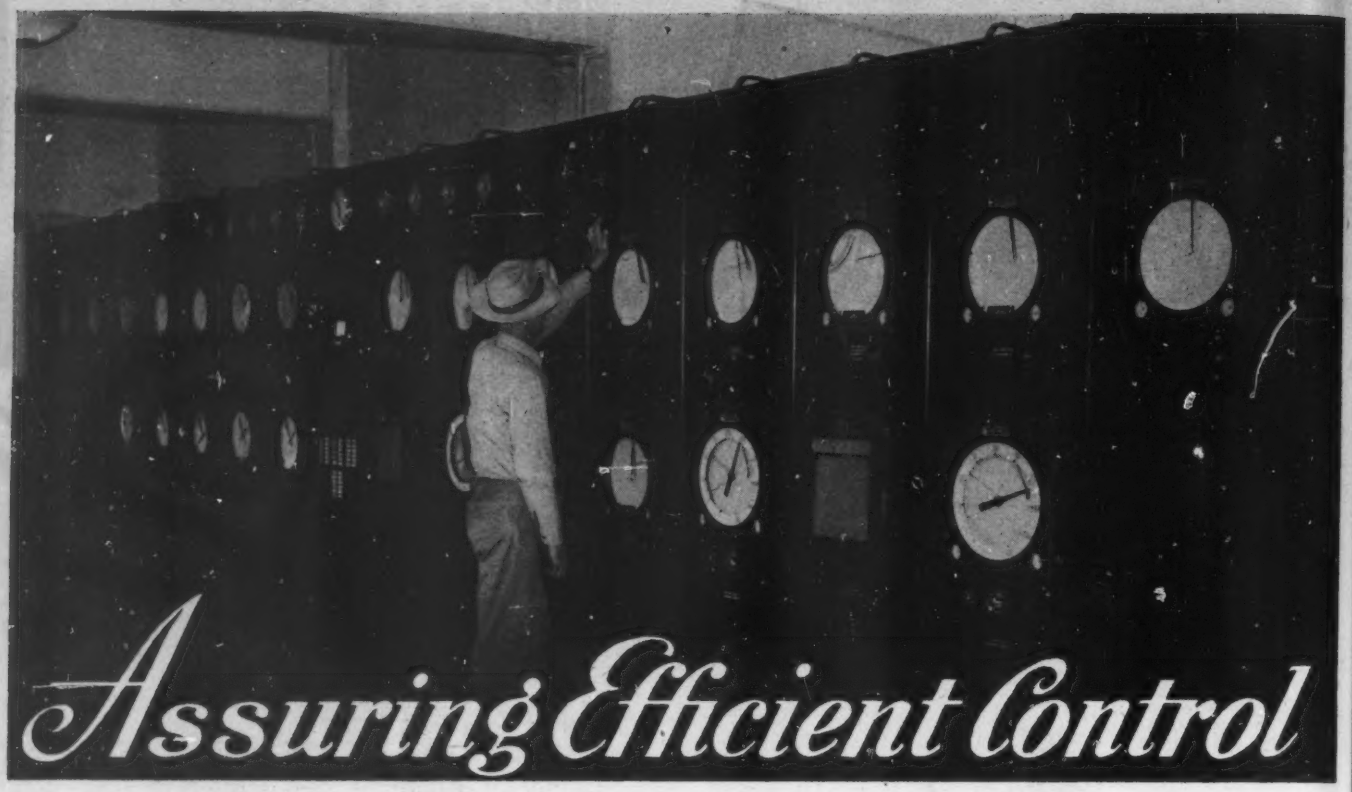


JM-1620 Fireblok	JM-20 Fireblok	JM-23 Fireblok	JM-26 Fireblok
for exposed temp. to 1600° F. As back-up to 2000° F.	for use up to 2000° F. Exposed or back-up	for use up to 2300° F. Exposed or back-up	for use up to 2600° F. Exposed or back-up

JOHNS-MANVILLE JM PRODUCTS

Johns-Manville
INDUSTRIAL INSULATIONS
FOR EVERY TEMPERATURE . . . FOR EVERY SERVICE


Experienced Personnel
PLUS Ample Equipment
ASSURE MORE SATISFACTORY WORK
TEXAS
COMPANY
PIPE BENDS
PIPE COILS
WELDED HEADERS
Pipe Fabricators
HOUSTON
TEXAS
OFFICE AND PLANT
301 FRIO STREET
WOODCREST 6-2659



Assuring Efficient Control

AT CITIES SERVICE REFINERY, Lake Charles, La.

DESIGNED and constructed by the M. W. Kellogg Co., New York, N. Y., this refinery is not only the world's first completely new, wholly integrated aviation fuel refinery and butadiene plant, but is one of the largest single refinery construction jobs in the history of the oil industry.

The Cities Service Refining Corporation plant at Lake Charles incorporates the latest technical developments including fluid type catalytic cracking, sulphuric acid alkylation, butane isomerization, crude distillation, and propane desalting and deasphalting units.

In the measurement and control of these processes Brown Air-O-Line ElectroniK Potentiometers are playing an important part in obtaining maximum yield at lowest cost. Advanced design and proven performance of the Brown Electronic "Continuous Balance" principle dictated the choice of these instruments.

The Brown ElectroniK Potentiometer is instantly positioned in response to temperature changes. Its "Continuous Balance" measuring system makes it possible to take full advantage of thermocouple responsiveness. Positive control action is assured by the well-known, dependable Brown Air-O-Line control unit, thousands of which are in service throughout industry.

In addition to the Brown ElectroniK Potentiometer—Brown Flow and Liquid Level, Thermometers and Pressure Controllers are also included on the above panel board.

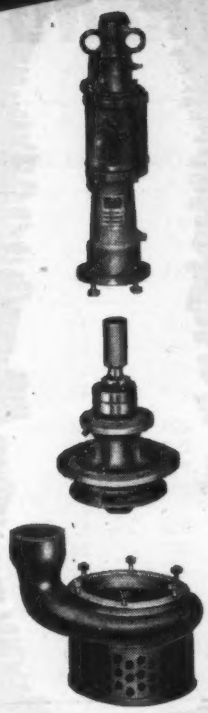
All of these instruments make possible the ideal synchronization of measurement and control of temperatures, pressures, flows, liquid levels. Here is another instance where Brown engineering and Instrumentation have kept pace with progress in the advanced technique of refinery processes which are now contributing to America's gasoline and synthetic rubber output.

To simplify your process control problem, call in a Brown engineer. Write THE BROWN INSTRUMENT COMPANY, 4498 Wayne Avenue, Philadelphia 44, Pennsylvania, a division of Minneapolis-Honeywell Regulator Company, Minneapolis, Minnesota. Offices in all principal cities. 119 Peter Street, Toronto, Canada—Wadsworth Road, Perivale, Middlesex, England — Nybrokajen 7, Stockholm, Sweden.

BROWN *ElectroniK*
POTENTIOMETERS

BYRON JACKSON

Pneumatic Sponge



BYRON JACKSON PNEUMATIC SPONGE CONSTRUCTION DETAIL

Impeller is a two-port, non-clogging type, of heat treated Meehanite affixed to a stainless steel shaft, supported by heavy, sealed, grease lubricated, duplex thrust and radial ball bearings. A renewable bronze wear ring, matching the impeller, is inserted within the suction cover.

Volute case, including suction and shaft covers, are of semi-steel. Connector between air motor and pump is of Meehanite and the steel studs, connecting the flanges, are provided with bronze nuts. A perforated steel plate attached to pump below the case serves as a screen to exclude gravel or debris that cannot be passed through pump.

Designed for pumping heads to 150 feet, in single stage, and 300 feet in two stages, the Byron Jackson Pneumatic Sponge finds wide application for use in refineries, on tank farms and in chemical plants for pumping out ditches, pits, tanks, sumps, basements, manholes or other similar applications where the pumped fluid contains a heavy percentage of solids.

Built either as a single stage unit, or in two stages, for series operation, the Pneumatic Sponge is a centrifugal pump, driven by a rotary air motor, operating on compressed air at pressures from 70 to 100 psi, suitable for operation in any position.

Compact, ruggedly constructed, yet light in weight, the sponge pump is quickly and easily moved from place to place; can be dismantled or converted from individual to parallel or series operation in minimum time and with minimum effort, without the possibility of misalignment.

Motor is equipped with a governor and variable speed control, thereby permitting regulation to suit particular conditions of the job.

Two standard sizes are available: 2½" in single or as a two stage unit and a 3" single stage low head unit. Write today for new Sponge Pump Bulletin No. 44-7035. Just off the press.

ARMY E NAVY

BYRON JACKSON CO.

Houston • Los Angeles • New York

2¾% Nickel Steel locomotive rods, one bent cold to show ductility.

QUENCHED AND TEMPERED NICKEL STEEL FORGINGS COMBINE

EXCEPTIONAL DUCTILITY WITH HIGH TENSILE STRENGTH

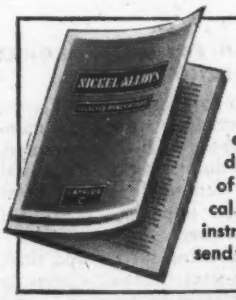
Composition and Typical Properties of Normalized Quenched and Tempered 2¾% Nickel Steel Rods

Description or Size	Melt Yield Pt. No. #s per Sq. In.	Tensile Strength #s per Sq. In.	Elong. % in 2 In.	Reduction in Area %	ANALYSIS					
					Car.	Mang.	Phos.	Sul.	Sil.	Ni
Main Rod....	92900	110000	25.0	64.4	.31	.78	.027	.026	.25	2.75
Main Rod....	86500	104500	25.5	65.6	.32	.86	.034	.032	.29	2.69
Main Rod....	86360	104400	26.0	64.8	.32	.86	.034	.032	.29	2.69
Main Rod....	87850	102350	26.0	66.2	.31	.89	.037	.025	.32	2.69
Front Rod....	86000	102250	25.0	67.3	.29	.82	.035	.027	.24	2.71
Front Rod....	83900	104250	25.0	66.1	.29	.82	.035	.027	.24	2.71
Front Rod....	86850	104250	27.0	66.1	.32	.86	.035	.025	.30	2.65
Front Rod....	89500	107050	25.5	65.6	.32	.86	.035	.025	.30	2.65
Back Rod....	89500	107650	25.0	62.7	.30	.79	.030	.025	.22	2.71
Back Rod....	87500	106450	25.0	65.4	.29	.82	.035	.027	.24	2.71
Back Rod....	87000	105600	25.0	65.4	.29	.82	.035	.027	.24	2.71
Back Rod....	88150	104850	26.0	66.8	.29	.82	.035	.027	.24	2.71

Specimens Taken from Mid-Section of Prolongations of the Forgings

The above table compiled by the American Locomotive Company shows the chemical compositions and mechanical properties of some normalized, quenched and tempered nickel steel front, main and back rods recently produced as replacement rods for locomotives being speeded up and rebalanced. These values are typical of replacement rod forgings recently tested by that company.

Quenched and tempered nickel steel forgings provide high tensile strength and ductility, combined with unusual toughness and high fatigue strength—qualities which tend to obviate breakage and assure long, trouble-free service when employed in heavy duty machinery and equipment.



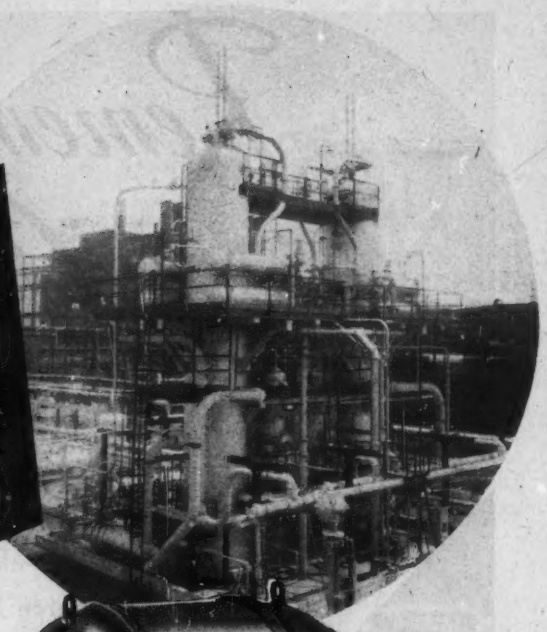
Catalog "C" makes it easy for you to get booklets and bulletins on industrial applications of Nickel, metallurgical data and working instructions. Why not send for your copy today?

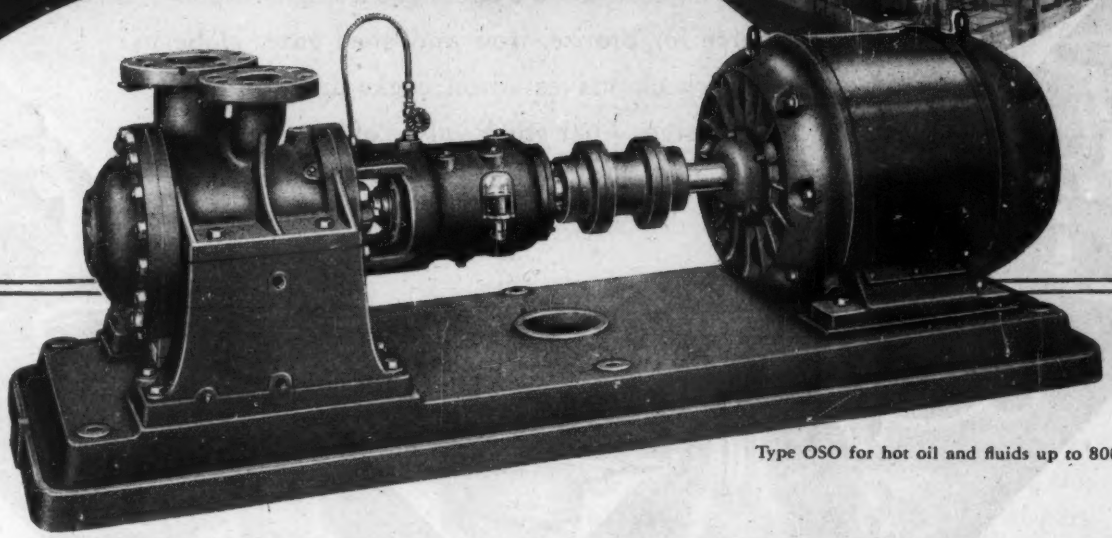
★ Nickel ★

THE INTERNATIONAL NICKEL COMPANY, INC., *67 Wall Street, New York 5, N. Y.*

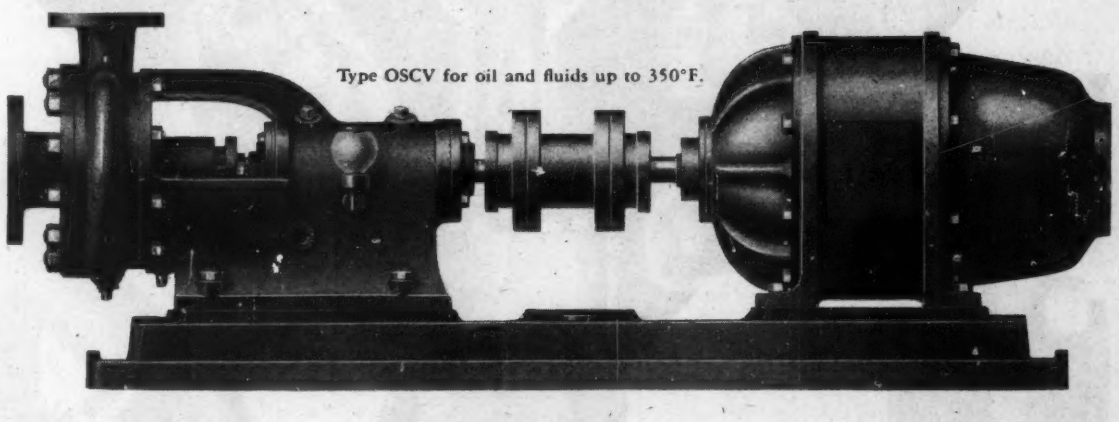
AMERICAN-MARSH PUMPS

••71 YEARS OF EXPERIENCE HAS GONE INTO THE BUILDING OF THESE MODERN PROCESS PUMPS





Type OSO for hot oil and fluids up to 800°F.



Type OSCV for oil and fluids up to 350°F.

EXPERIENCE that pre-dates the great petroleum industry by many years is behind American-Marsh pumps. Such experience assures you that all known factors for improving efficiency are incorporated in modern American-Marsh design. And since we have kept in step with the fast progress of the petroleum industry, we are prepared to handle all of the exacting requirements of modern process pumps. Write us today.

Horizontally split case type units as well as multi-stage units are available.

CENTRIFUGAL, TURBINE, STEAM AND POWER PUMPS

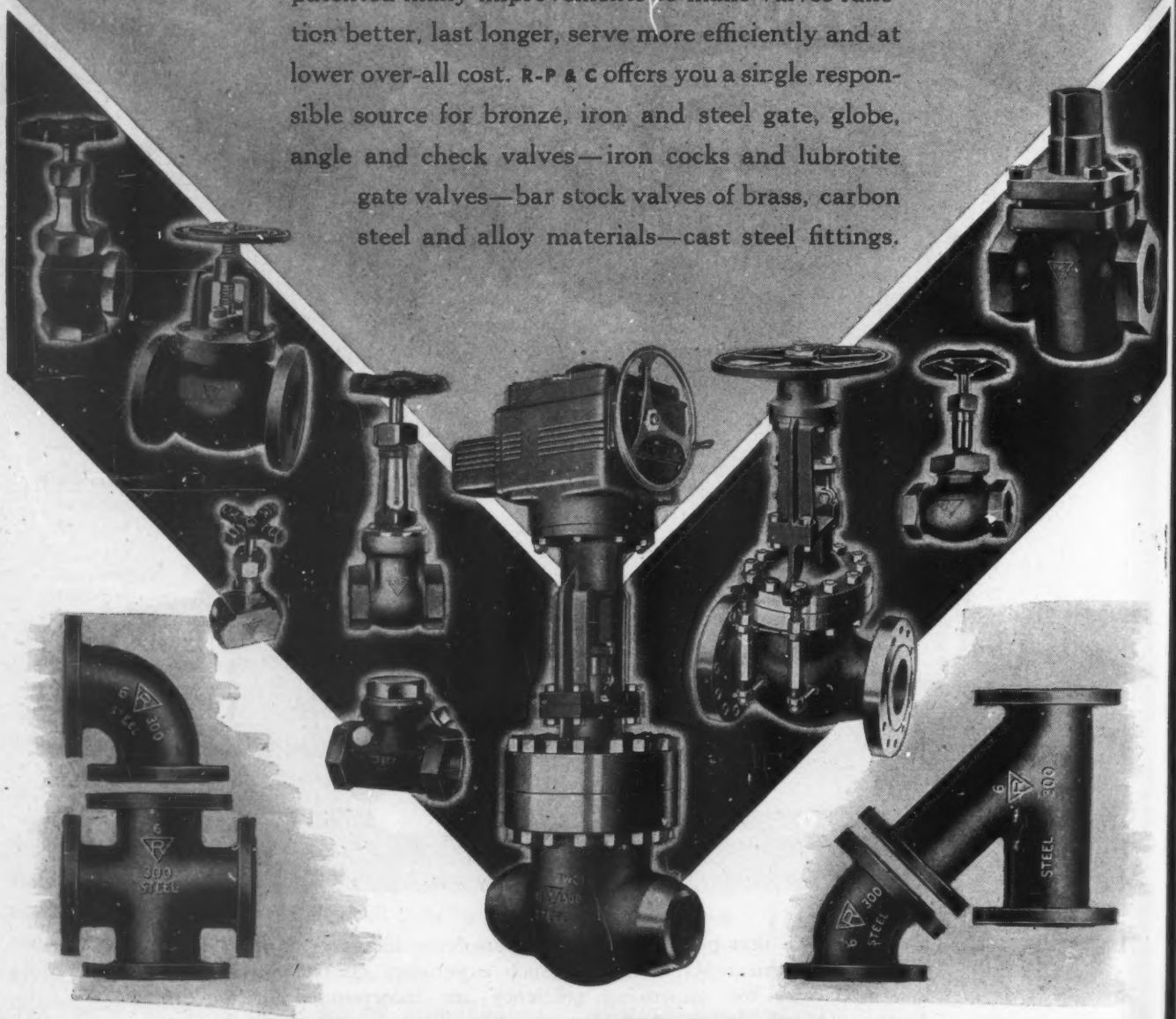
AMERICAN-MARSH PUMPS INC.
BATTLE CREEK, MICHIGAN

PUMPS, AND PUMPS ONLY ONLY SINCE 1873

Remember THIS WHEN YOU NEED Good Valves

R P&C CO J&E

READING-PRATT & CADY has been making good valves for many years—has, in fact, originated and patented many improvements to make valves function better, last longer, serve more efficiently and at lower over-all cost. **R-P & C** offers you a single responsible source for bronze, iron and steel gate, globe, angle and check valves—iron cocks and lubrotite gate valves—bar stock valves of brass, carbon steel and alloy materials—cast steel fittings.



READING-PRATT & CADY

MANUFACTURERS OF

READING CAST STEEL VALVES AND FITTINGS • PRATT & CADY BRASS AND IRON VALVES
D'ESTE VALVE AND ENGINEERING SPECIALTIES

Reading, Pa., Atlanta, Boston, Chicago, Denver, Houston, Los Angeles, New York, Philadelphia, Pittsburgh, San Francisco

ACCO

A DIVISION OF AMERICAN CHAIN & CABLE COMPANY, Inc., BRIDGEPORT, CONNECTICUT

which of these CHASE BI-METAL TUBES meets your severe *double* corrosion problems better?

CHASE

To prevent costly corrosion of heat exchanger tubes—from cooling water within and corrosive vapor without—progressive oil refineries and petroleum chemical plants rely on bi-metal tube.

The bi-metal tube is really two tubes of different metals tightly fitted together. A few suggested combinations are steel and Antimonial-Admiralty, steel and red brass, or steel and copper, with the nonferrous alloy either on the inside or outside of the tube. In this way, both interior and exterior surfaces are better able to withstand the corrosive attack to be encountered.

Chase engineers, with the wide selection of ferrous and nonferrous alloys at their disposal, have developed the bi-metal tube to a high degree of perfection . . . devised a right combination of materials to meet practically any set of corrosive conditions in the oil refinery and synthetic rubber fields.

If you are confronted with this *double* corrosion problem, it will pay you to consult Chase. You are assured, then, not only of oil-side *and* water-side protection, but of the engineering knowledge and skill required to produce the most suitable combination of metals for your operating conditions.

CHASE BRASS & COPPER CO.

— Incorporated —

Waterbury 91, Connecticut

SUBSIDIARY OF KENNECOTT COPPER CORPORATION

ALBANY †
ATLANTA †
BALTIMORE
BOSTON
CHICAGO
CINCINNATI
CLEVELAND
DETROIT
HOUSTON
INDIANAPOLIS †
KANSAS CITY, MO. †
LOS ANGELES
MILWAUKEE

MINNEAPOLIS
NEWARK
NEW ORLEANS
NEW YORK
PHILADELPHIA
PITTSBURGH
PROVIDENCE
ROCHESTER †
SAN FRANCISCO
SEATTLE
ST. LOUIS
WASHINGTON †

† Indicates Sales Office Only

This is the Chase Network—handiest way to buy brass

FOR LOW COST SOLVENT REFINING POST WAR . . .

Get your Furfural Solvent Refining on the drafting boards today!

Lower in cost . . . simpler to operate and control

YOUR post-war need to meet competition is answered by Furfural Solvent Refining.

The process offers these outstanding advantages—simplicity of operation and control—adaptability to any crude—freedom from hazards to health—lower cost—and high quality product.

The time to get your post-war Furfural Solvent Refining units on the drafting boards is now.

TEXACO DEVELOPMENT CORPORATION

A Subsidiary of The Texas Company

CONTROLLED QUALITY ASSURES

Ladish green-colored forged steel Long Welding Necks are produced with the same rigid metallurgical control of quality and identity that typifies all Ladish products.

Complete range of sizes in pressure ratings from 150 through 1500 p.s.i. in both carbon and alloy steels.

Steel identity stamped on each flange was pioneered by Ladish and has been a Ladish standard for many years

TO MARK PROGRESS

ARMY E NAVY

FITTINGS DIVISION

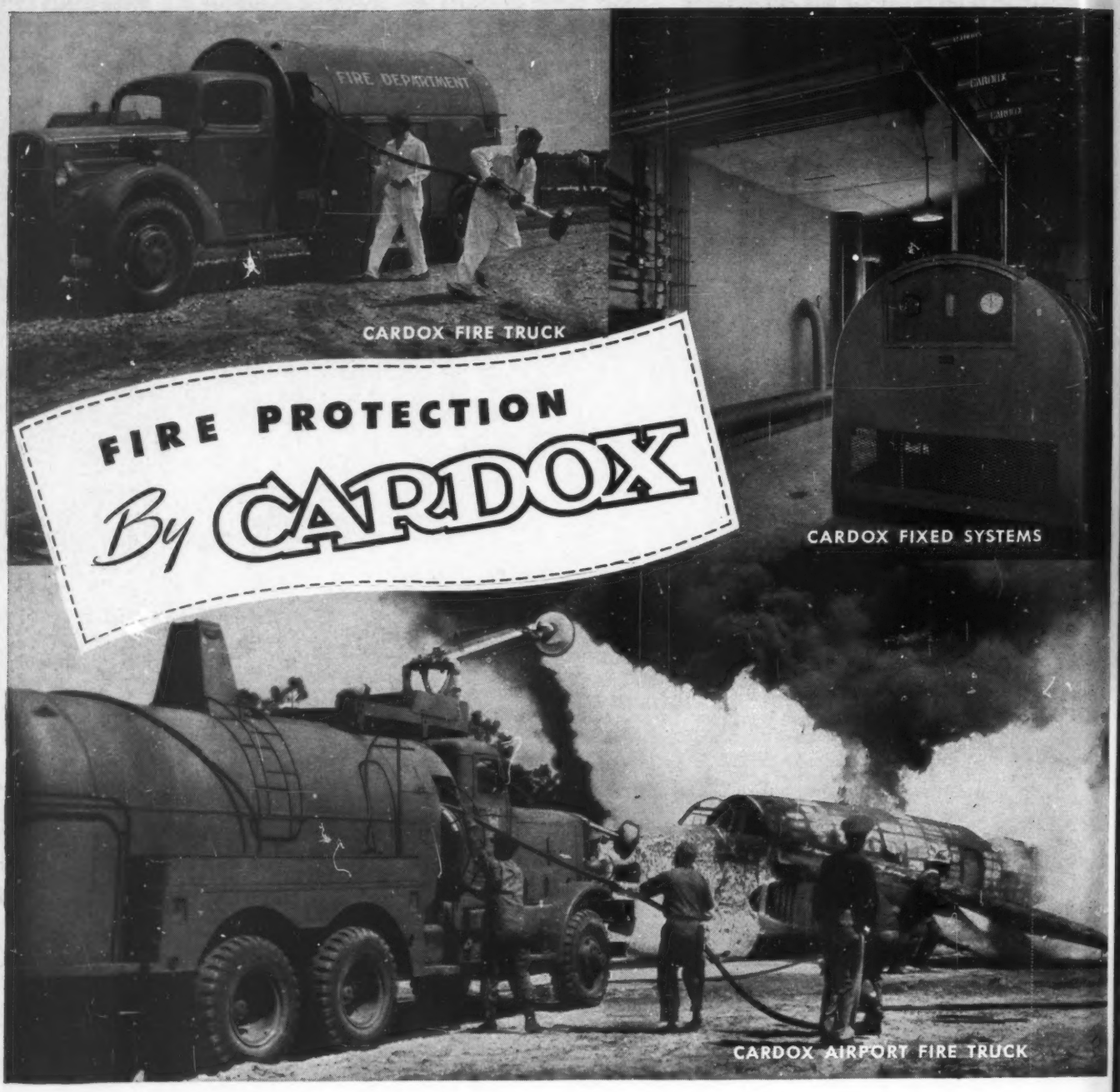
LADISH DROP FORGE CO.

CUDAHY • WISCONSIN

MILWAUKEE SUBURB

District Offices:

Lincoln Building, New York City — Rockefeller Building, Cleveland
Peoples Gas Building, Pittsburgh — Sterling Building, Houston
Petroleum Building, Los Angeles



In and around America's vital war plants . . . on our big and busy military airfields . . . fire protection is provided by Cardox Fire Extinguishing Systems, Fire Trucks and Airport Fire Trucks.

Each is a highly specialized fire extinguishing tool . . . exactingly engineered to do a specific job quicker and more effectively than it has been done before. But all Cardox Systems and Mobile Units have one outstanding characteristic in common: *Cardox Engineering in the application and control of carbon dioxide, stored at 0°F. and 300 p.s.i. in a single Storage Unit containing from ¼ to 125 tons of fire-destroying Cardox CO_2.*

For Cardox has given the recognized advantages of carbon dioxide a new and broader scope of fire extinguishing performance. Because of this, these advantages can be applied equally well to small or *very large* fires through *mass* application of Cardox CO_2, released in *pounds* or *tons.*

The efficiency of Cardox Systems and Mobile Units in giving fast-acting, nondamaging carbon dioxide *enhanced extinguishing* performance is made possible by Cardox methods of control and application that give Cardox CO_2: (1) Uniform extinguishing characteristics regardless of plant or atmospheric temperatures; (2) Availability in ample quantity for uninterrupted protection and mass application at high rate; (3) High CO_2 "snow" yield for increased cooling effect; (4) Effective projection through relatively great distances.

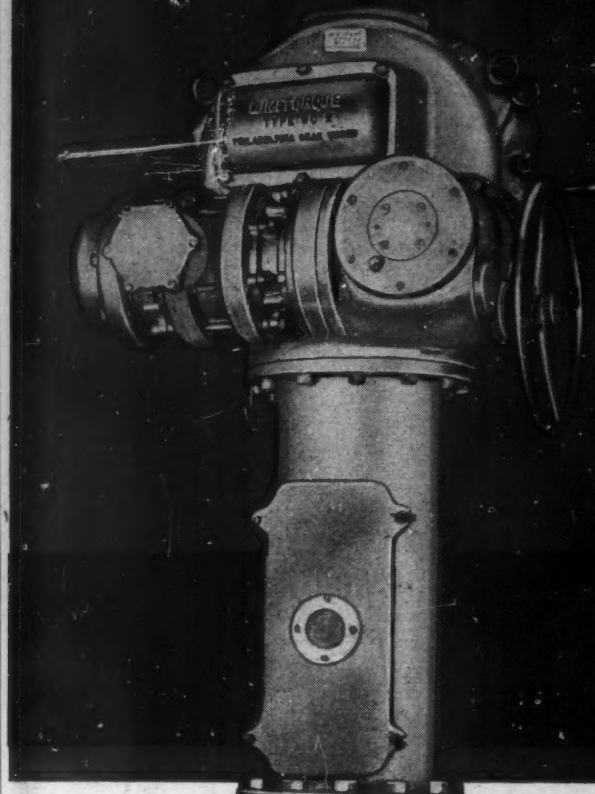
On the basis of this performance Cardox has been given many of the toughest fire protection assignments—*all over the country.* Find out how through practical cooperation Cardox and its engineering staff can assist you to make your planned fire protection more effective. Write on company letterhead for Bulletin 2412.

CARDOX CORPORATION
BELL BUILDING • CHICAGO 1, ILLINOIS

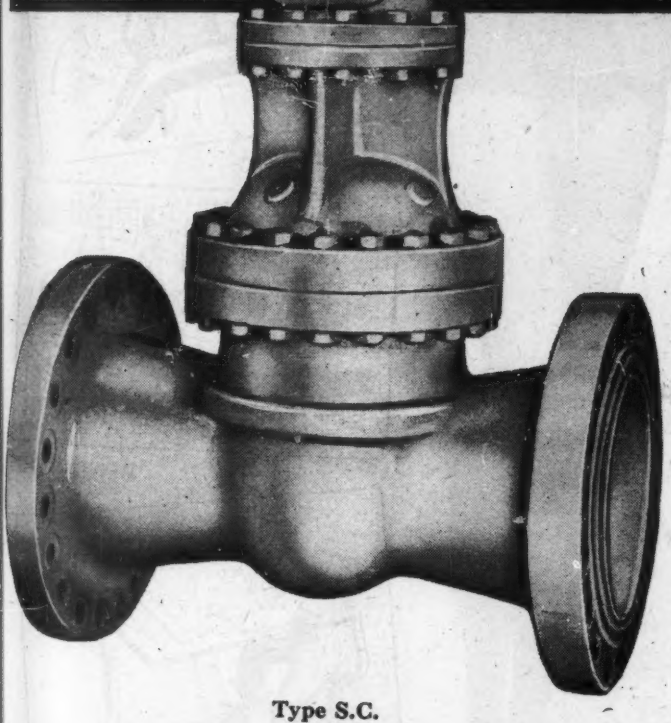
District Offices in New York • Boston • Washington
Detroit • Cleveland • Atlanta • Pittsburgh
San Francisco • Los Angeles • Seattle

CARDOX
CO_2 FIRE EXTINGUISHING SYSTEMS

FREEDOM FROM DOWN-TIME



LIMITORQUE VALVE CONTROL



Type S.C.

Outstanding records have been made by Limi-Torque Controls in a great many refineries where they are being kept in continued operation for unusually long periods without requiring maintenance or repairs. It has been definitely demonstrated that LimiTorques are so reliable that even in cycling plants, the hearts of the refineries, Auxiliaries or stand-bys are unnecessary. This dependability that is now permitting greater production of war-needed petroleum products will prove a definite aid to more economical operation in the days to come. To date there are more than 90% of the plants producing straight run or high test aviation are equipped with LimiTorque Valve Controls . . . a real indication of their readily recognizable superiority.

For all types of refinery valves, including gates, globes, plugs, cocks . . . high or low temperatures and pressures . . . LimiTorque is applicable.

The Type S.C., a crank type mechanism, opens and closes valves much faster than can a conventional type operator. For example a 24" valve can be opened in only 3 seconds instead of the usual 15 or 20 seconds.

For further details write us.

ARMY E NAVY

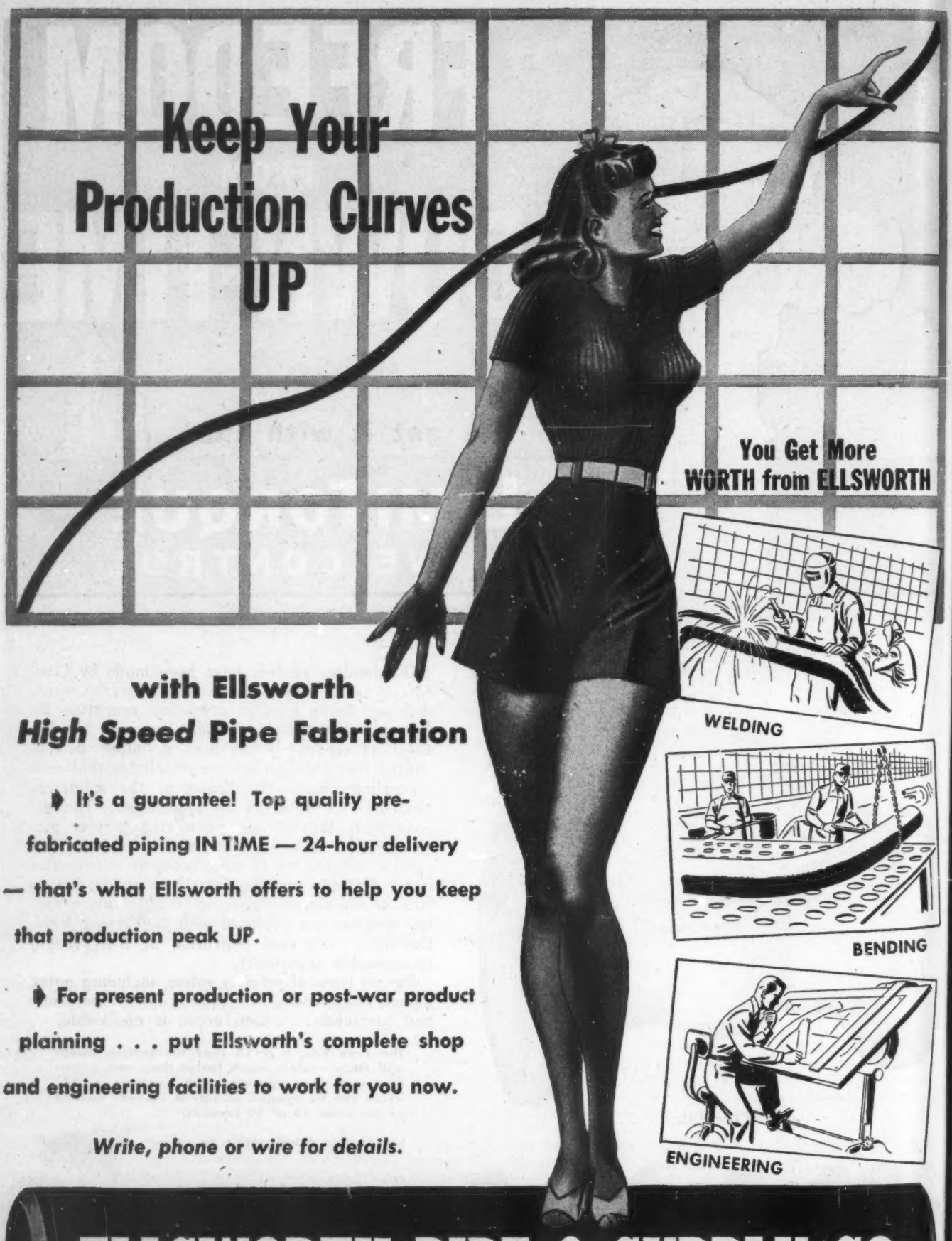
Philadelphia

GEAR WORKS INCORPORATED

ERIE AVE. AND G ST., PHILADELPHIA 34, PA. NEW YORK • PITTSBURGH • CHICAGO

Industrial Gears and Speed Reducers
LimiTorque Valve Controls

Keep Your Production Curves UP



You Get More WORTH from ELLSWORTH

WELDING

BENDING

ENGINEERING

with Ellsworth *High Speed* Pipe Fabrication

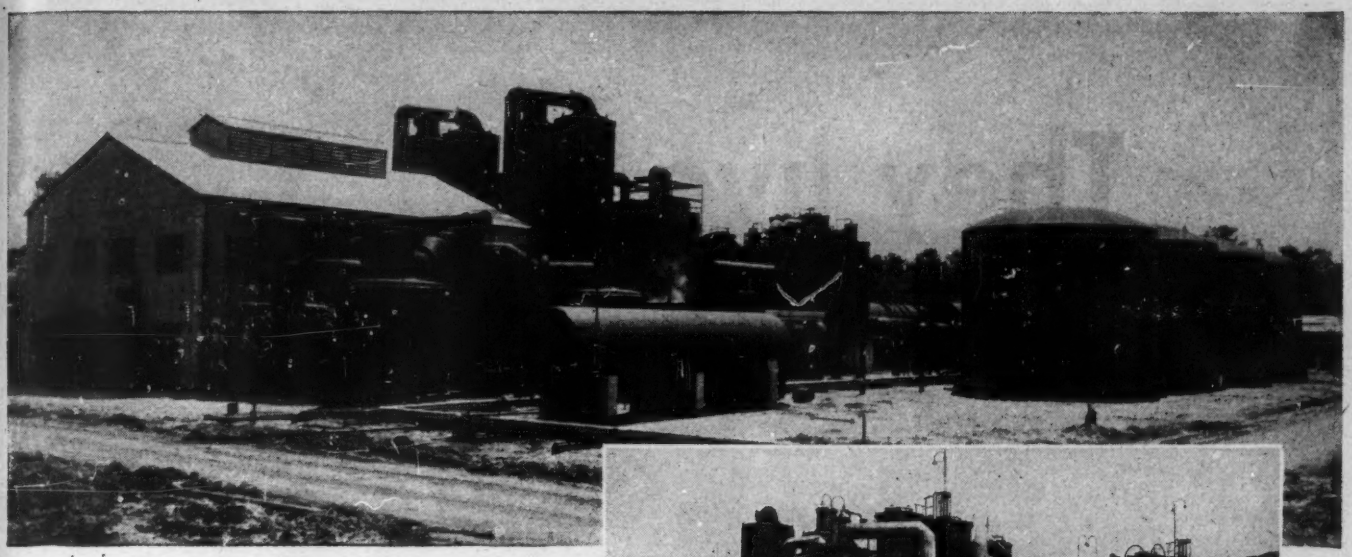
It's a guarantee! Top quality pre-fabricated piping IN TIME — 24-hour delivery — that's what Ellsworth offers to help you keep that production peak UP.

For present production or post-war product planning . . . put Ellsworth's complete shop and engineering facilities to work for you now.

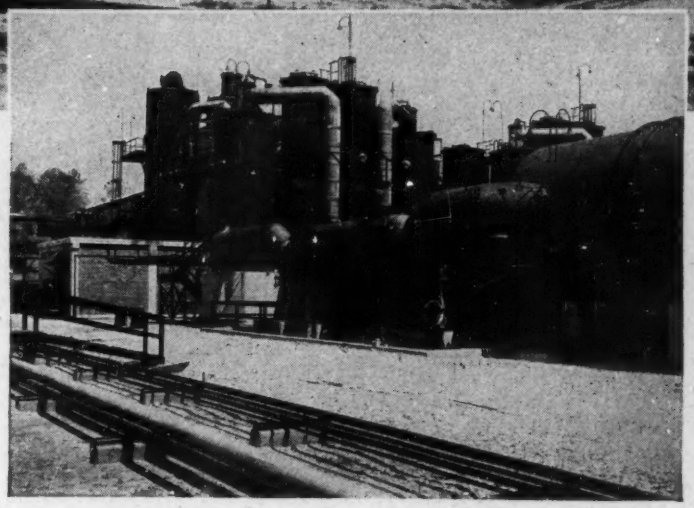
Write, phone or wire for details.

ELLSWORTH PIPE & SUPPLY CO.

1739 WEST ST. PAUL AVENUE MILWAUKEE 3, WISCONSIN



Two views of the CHEMICO Sulphuric Acid Regeneration Plant at a representative refinery.



In Many Refineries

ALL ACID REQUIREMENTS are supplied by a CHEMICO PLANT

The CHEMICO Acid Regeneration Process has been selected for outstanding refineries all over the world because it has proven to be the most modern and economical method of reclaiming waste sulphuric acid and also for producing make-up acid.

The CHEMICO Regeneration Process operates at high temperature which completely consumes the hydrocarbons in the spent acid while decomposing the acid into its components of sulphur dioxide, oxygen and water; also producing additional sulphur dioxide from raw sulphur for make-up acid. The sulphur dioxide is then processed to fresh acid of 98% strength.

Additional advantages of the CHEMICO Regeneration Process are its moderate investment, low operating cost, and absence of by-products and fume nuisance.

CHEMICO
CHEMICAL CONSTRUCTION CORP.

CHEMICAL CONSTRUCTION CORPORATION
A unit of AMERICAN CYANAMID COMPANY
30 Rockefeller Plaze — New York 20, N. Y.
European Representatives, Cyanamid Products, Ltd.,
Berkhamsted, Herts, England
Cables, Chemiconst, New York

CHEMICO PLANTS are PROFITABLE INVESTMENTS

They live on dreams

Rice. That's what our boys in the Japanese prison camps eat.

They get it for breakfast, garnished with taunts. For lunch, seasoned with threats. For dinner, covered with verbal abuse.

Twenty thousand Americans, day after day, week after week, month after month until they are liberated, will live on this fare. Twenty thousand—and more.

But it is more than rice that they live on. For they live on dreams. Dreams of hearing, one day, the guns of the American battle squadrons drawing nearer. Dreams of hearing in the sky the thunder of American planes. Dreams of hearing in the streets the shouts of American voices —liberating American voices.

For these twenty thousand the war will not end—barring a miracle—next month or the month after that or even by next spring or summer.

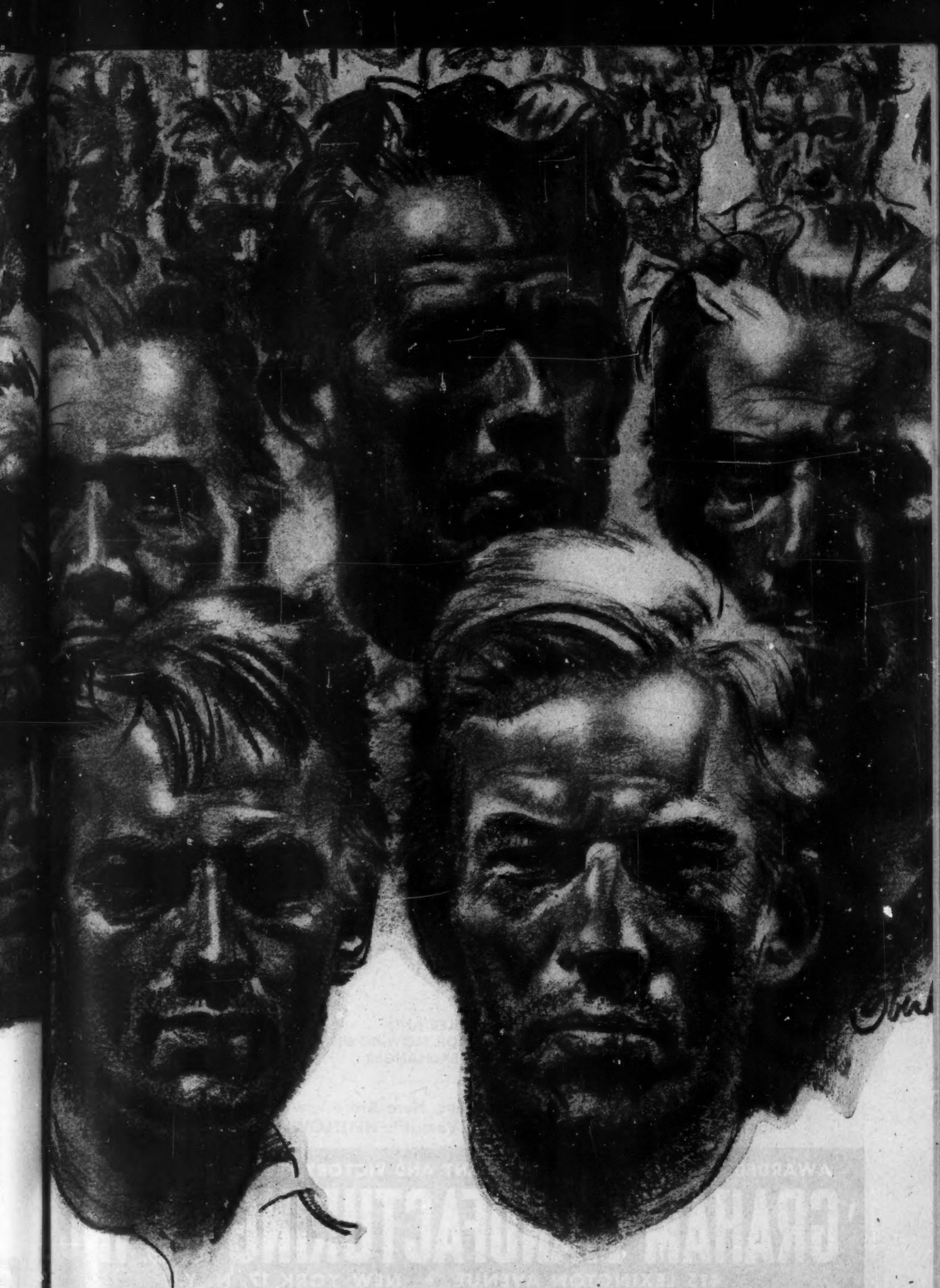
It *will* end sooner, however, if not a single one of us lets down. If every one of us fights and works and invests in War Bonds right up to the last minute. It's the only way to speed victory.

How many extra Bonds are *you* buying?

6th War Loan

BUY MORE THAN BEFORE

THIS ADVERTISEMENT CONTRIBUTED BY ALCO PRODUCTIV



DUC IVISION OF AMERICAN LOCOMOTIVE COMPANY

"HELIFLOW"
COOLERS AND HEATERS

JACKET WATER COOLER FOR DIESEL ENGINES AND COMPRESSORS

LUBRICATING OIL HEATER FOR LUBRICATING OIL PURIFIERS

LUBRICATING OIL COOLER FOR DIESEL OR STEAM POWER PLANT

ACID HEATER AND COOLER

COOLING QUENCH OR TRANSFORMER OIL

ASPHALT HEATER AND COOLER

SUGAR JUICE HEATERS AND MOLASSES HEATERS

ELECTRO PLATING BATH COOLER

FREON OR REFRIGERANT COOLER

GALLEY WATER HEATER

DISTILLER CONDENSER

BOILER WATER LEVEL HEATER

VENT CONDENSER

DOMESTIC HOT WATER HEATER

FEED WATER HEATER

FUEL OIL HEATER

BOILER WATER SAMPLE COOLER

BOILER AND EVAPORATOR BLOW-DOWN HEAT EXCHANGER

The Heat Exchanger of a Thousand Uses, Here Are a Few Examples of Possible Applications of the Compact, Efficient, Versatile HELIFLOW. Send for Bulletin 58.

AWARDED THE MARITIME "M" PENNANT AND VICTORY FLEET FLAG APRIL 8, 1944

GRAHAM MANUFACTURING CO. INC.

415 LEXINGTON AVENUE • NEW YORK 17, N. Y.

Use HASTELLOY Nickel-Base Alloys

Made In Four Types, A, B, C, and D

for resistance to

HCl.... H_2SO_4.... and Other Corrosives

HASTELLOY alloys are high-strength metals that resist chemical corrosion under severe conditions. These alloys are particularly remarkable for resistance to *hot hydrochloric* acid and *sulphuric* acid, in varying concentrations and temperatures. HASTELLOY alloys resist other mineral acids also, as well as organic acids, oxidizing agents, and oxidizing salts. They are among the few materials available for handling fluorides.

Fabricated Units Available

In addition to the available forms outlined in the table at right, complete units fabricated from HASTELLOY alloys can be obtained. Autoclaves, evaporators, agitator units, fractionating columns, and other equipment are being made regularly . . . in our plant or by well-known fabricators.

Send for 40-Page Booklet

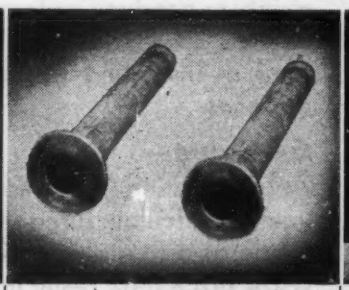
The booklet, *"Hastelloy High-Strength Alloys"* contains complete information on HASTELLOY alloys, including results of penetration tests and methods of fabrication. A copy will be sent on request.

These Are Some of the Corrosives They Resist		These Are Some of Their Available Forms		These Are Some Ways You Can Work Them	
Media	Alloys	Forms	Alloys	Methods	Alloys
H_2SO_4, Dilute	A, B, C, D	Castings	A, B, C, D	Grinding	A, B, C, D
H_2SO_4, Concentrated	D	Welding Rod	A, B, C, D	Welding (Oxy-Acetylene)	A, B, C, D
HCl, Room Temp.	A, B, C	Rolled Sheet	A, B, C		
HCl, Boiling	B	Plate	A, B, C	Welding (Electric)	A, B, C
Organic Acids	A, B, C, D	Welded Tubing	A, B, C		
Acid Chlorides (Non-Oxidizing)	A, B, C	Bars (Hot-Rolled)	A, B	Machining	A, B, C
Acid Sulphates (Non-Oxidizing)	A, B, C, D	Forgings	A, B	Cold-Forming	A, B, C
Oxidizing Media	C	Wire	A, B	Hot-Forging	A, B

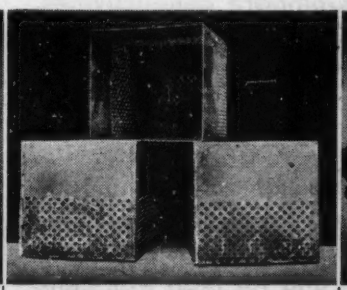
These Are Some of Their Mechanical Properties

Alloys	Forms	Tensile Strength, lb. per sq. in.	Elongation in 2 in., per cent	Hardness, Brinell
A	Cast	69,000- 77,000	8-12	155-200
A	Rolled, Annealed	110,000-120,000	40-48	200-215
B	Cast	75,000- 82,000	6- 9	190-230
B	Rolled, Annealed	130,000-140,000	40-45	210-235
C	Cast	72,000- 80,000	10-15	175-215
C	Rolled, Annealed	115,000-128,000	25-50	160-210
D	Cast	36,000- 40,000	0	425-485

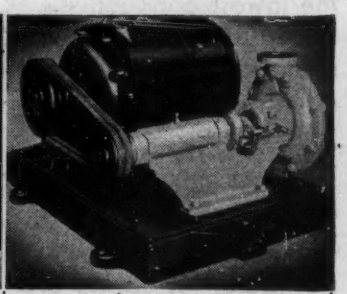
Valve parts cast of alloy C for a chlorination unit



6 ft. long alloy D tubes for concentrating H_2SO_4



Pickling baskets fabricated from alloy A sheet



Alloy B chemical pump for handling hot HCl

HASTELLOY TRADE-MARK

HAYNES STELLITE COMPANY

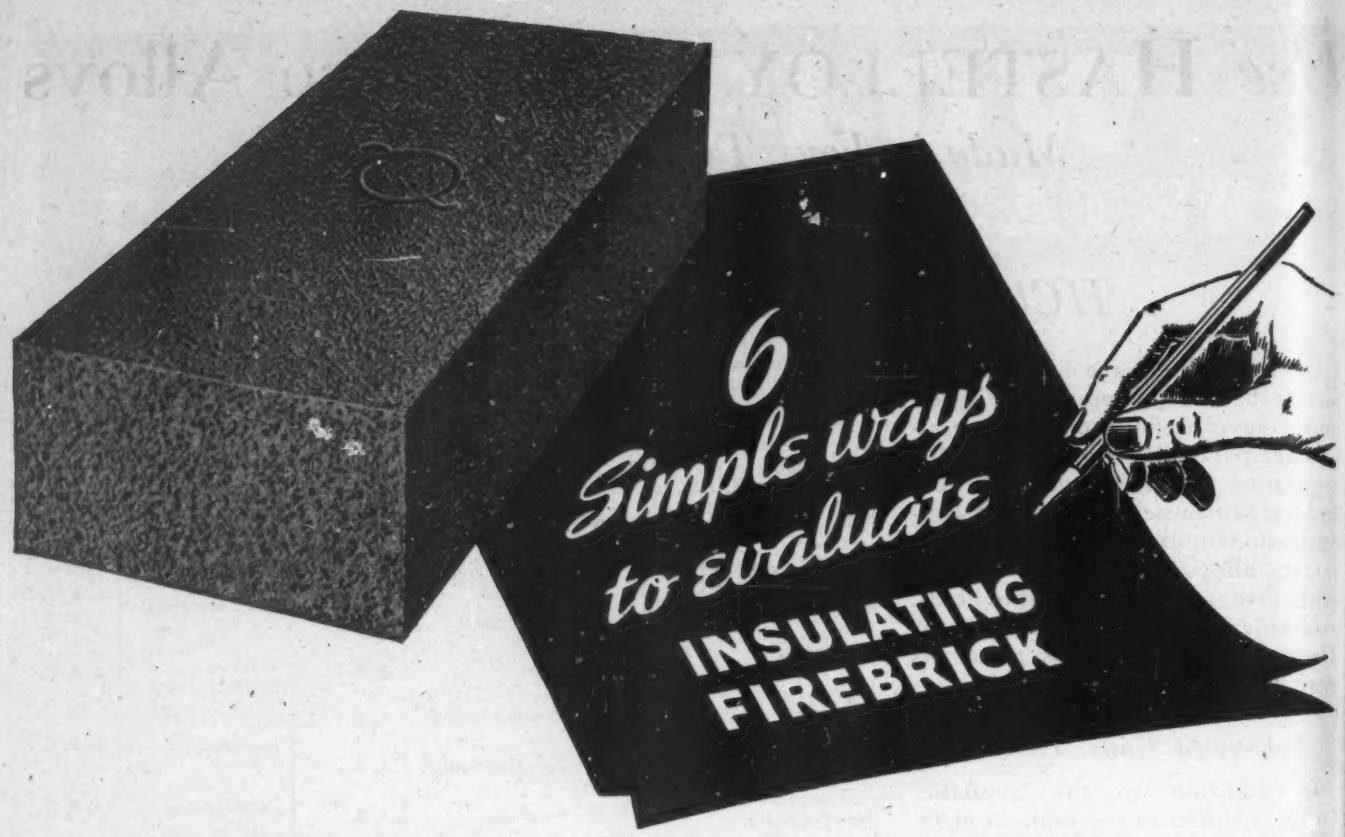
Unit of Union Carbide and Carbon Corporation

New York, N. Y. UCC Kokomo, Indiana

Chicago—Cleveland—Detroit—Houston—Los Angeles—San Francisco—Tulsa

HIGH-STRENGTH NICKEL-BASE ALLOYS FOR CORROSION RESISTANCE

The word "Hastelloy" is a registered trade-mark of Haynes Stellite Company.



Different grades and makes of Insulating Firebrick have widely differing properties. To obtain the maximum value for a given application, select the brick that will best fulfill the following:

1—*Limiting Service Temperature*—
The group or grade of insulating firebrick is established by the maximum temperature at which your furnace will operate. Select the group or grade next above this temperature.

2—*Weight and Conductivity*—
Generally, the lighter the brick, the lower the conductivity will be. Heat losses can be kept at the minimum only by selecting the lightest brick with the lowest conductivity. Compare conductivities based on ASTM test C-182-43T. Do not compare results obtained by different testing methods; they cannot be correlated.

3—*Stability*—
Cold crushing strength does not always indicate the stability of an insulating firebrick under fire. Compare the hot-load strengths. This is an essential factor for spring arch and for high wall construction and an important indication of length of service to be expected.

4—*Durability*—
Insulating firebrick should show little or no permanent volume change after heating to their recommended temperature limits. Compare results based on ASTM test C-93-42.

5—*Responsibility*—
Consider the manufacturer's responsibility, his ability to produce uniformly high quality materials, and his knowledge and experience with applications of insulating firebrick to different types of furnaces.

6—*Value*—
An evaluation of benefits and advantages for your particular furnace application should be made as a final step. Price alone is no criterion—a low price may result in an expensive investment.

Your local B&W representative will be glad to give you the necessary information on B&W Insulating Firebrick to make this kind of an evaluation.

THE BABCOCK & WILCOX CO. *Refractories Division* **85 Liberty St., New York 6, N. Y.** R-176

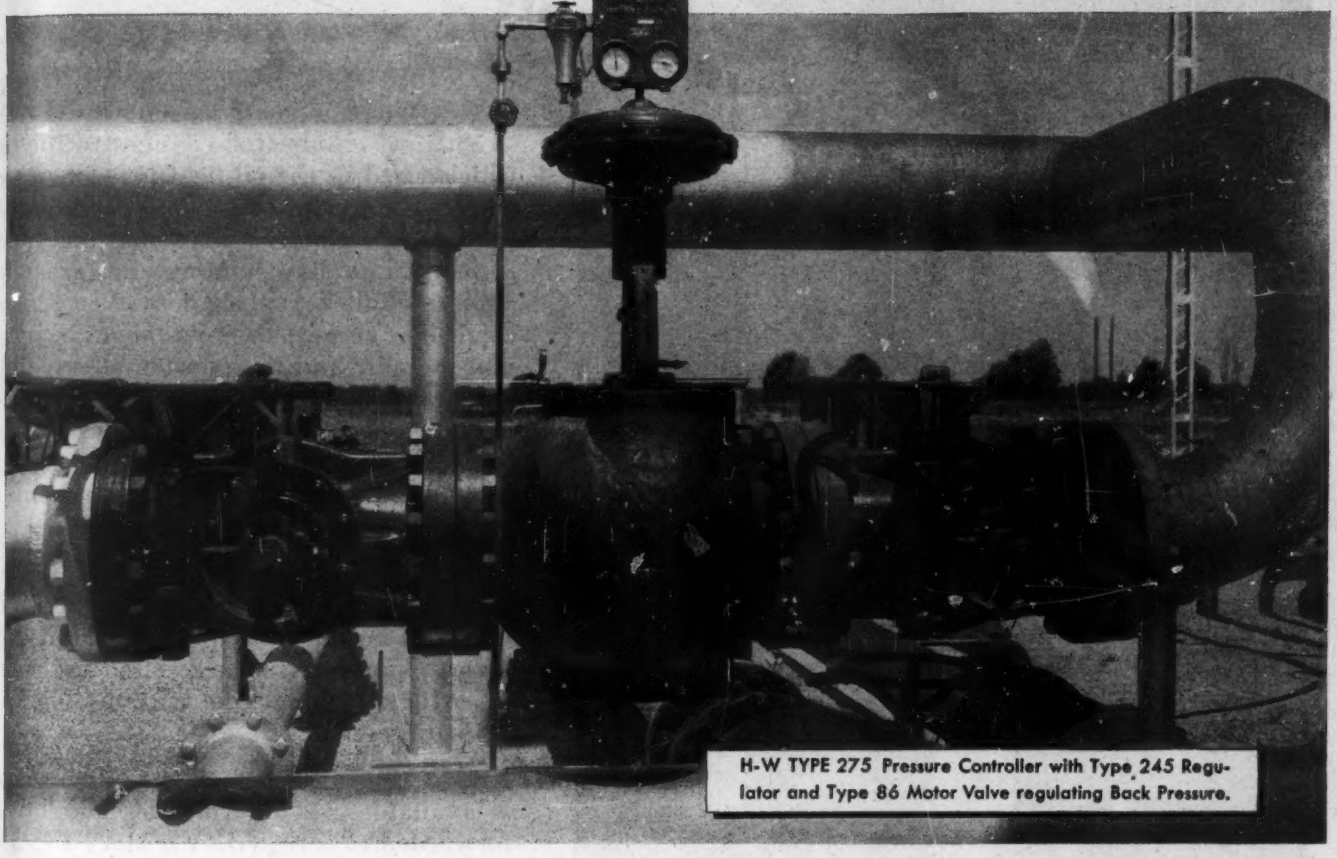
BUY MORE WAR BONDS!

BABCOCK & WILCOX

ARMY E NAVY

For Maximum EFFICIENCY and ECONOMY

CO-ORDINATE CONTROLS



H-W TYPE 275 Pressure Controller with Type 245 Regulator and Type 86 Motor Valve regulating Back Pressure.

A CONTROL INSTRUMENT is "No better than its motor valve," say production men, who *know* that all controls in any system must be so coordinated that each will function in precisely correct relationship to the others with which it operates.

That's why Hanlon-Waters engineers are called in—when specifications are being written on major jobs—to insure right sizing and correct application.

HANLON-WATERS engineering skill, experience and responsibility not only govern the design and manufacture of precision controls, but *extend to their correct installation for maximum efficiency and economy.* That is why—wherever there are oil wells, refineries or pipe lines—the name Hanlon-Waters has come to stand for practical, dependable, soundly engineered controls and auxiliary control equipment.

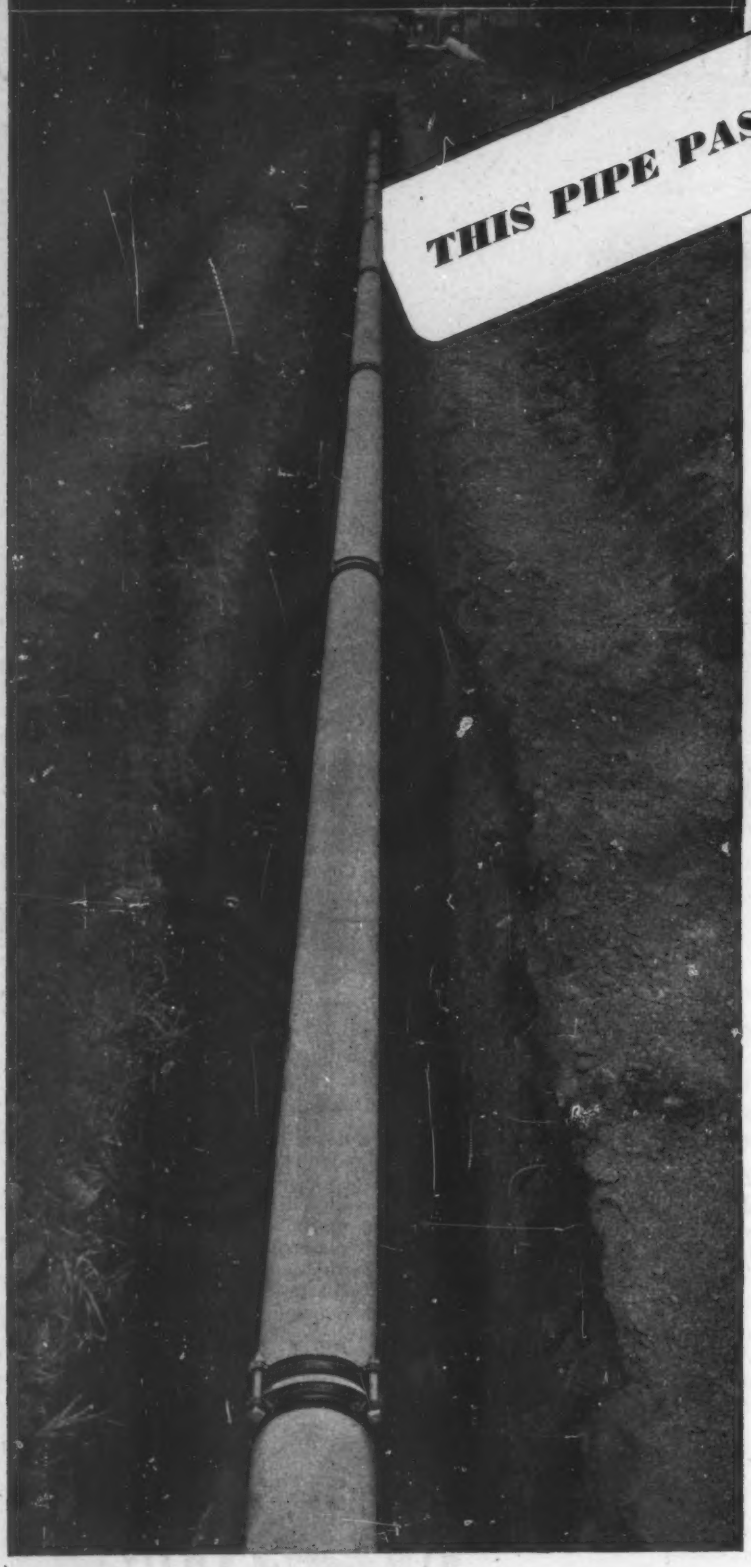
An affiliated company, McAlear Manufacturing Company, Chicago, is the leading producer of similar devices for industrial, processing, heating and power plants. Together these two companies manufacture upwards of 500 control devices, *only a few of which are listed below.* Products and engineering services of both companies are available through Hanlon-Waters.

If You Have a Control Problem, call on Hanlon-Waters engineers. Draw on their fund of experience . . . on their readiness and willingness to help you develop special controls where *unusual* conditions require them. Despite heavy war production, Hanlon-Waters deliveries are prompt. For informative bulletins and catalog, write Hanlon-Waters, 13 N. Cincinnati Street, Tulsa, Okla. *Affiliated with McAlear Manufacturing Company, Chicago; Climax Engineering Co., Clinton, Ia.*

PRESSURE REDUCING VALVES
BACK PRESSURE VALVES
STOP AND CHECK VALVES
PRESSURE REGULATING VALVES
PRESSURE AND VACUUM RELIEF VALVES
DIAPHRAGM VALVES
DIAPHRAGM MOTOR VALVES
TEMPERATURE REGULATORS
LIQUID LEVEL CONTROLLERS
LEVEL CONTROL PILOTS
PRESSURE CONTROL PILOTS
BOILER WATER FEEDERS
FEED WATER REGULATORS
FLOAT VALVES
LEVER VALVES
PIPE LINE STRAINERS
PUMP GOVERNORS
DRAINERS
TRAPS
GAS SAFETY VALVES
WATER ACCUMULATORS
RATE OF FLOW CONTROLLERS
EXHAUST RELIEF VALVES
EXHAUST HEADS
ELECTRIC PUMP CONTROLLERS
ALTITUDE VALVES
ALTITUDE RELIEF VALVES
BALL FLOATS
AIR VALVES
THREE WAY VALVES
CHECK VALVES
BUCKET TRAPS
BOLTED AND WELDED STEEL TANKS
PORTABLE PIPE LINES
PIPE LINE COUPLINGS
OIL AND GAS SEPARATORS

H-W McALEAR controls
PRESSURE · FLOW · LIQUID LEVEL · TEMPERATURE
for STEAM, WATER, AIR, OIL-GAS
WELDED TANKS
BOLTED TANKS
SEPARATORS

Nature made Asbestos – HERE IS HOW KEASBEY & MATTISON IS MAKING IT SERVE THE OIL FIELD



THIS PIPE PASSED ITS "PHYSICAL"

There is good reason why K&M "Century" Asbestos-Cement Pipe is widely used in the oil field for salt water disposal and for oil conveyance! It's immune to costly tuberculation from *within* . . . no flow-hamper, no pressure cuts, no quick replacements. It resists corrosive action from *without* . . . it is non-metallic and therefore unaffected by electrolysis. You can count on permanently smooth, free-flowing lines—without ordinary service interruptions . . . when you use K&M "Century" Asbestos-Cement Pipe.

"Century" is very moderate in price. The amount of labor required to install it is low, because "Century" is light and easy to handle. And there's real saving in "Century's" long life without expensive upkeep.

K&M "Century" Asbestos-Cement Pipe is available NOW. Inquiries should be forwarded to KEASBEY & MATTISON CO., or to the SOUTH CHESTER TUBE CO., K&M's authorized distributor to the Oil Industry, with main offices at Chester, Pa., and branches at:

Fort Worth, Texas . . . . . Petroleum Bldg.
Houston, Texas . . . . . Niels-Esperson Bldg.
Tulsa, Okla. . . . . Hunt Bldg.
Wichita, Kansas . . . . . 1717 North Hillside

KEASBEY & MATTISON

COMPANY · AMBLER · PENNSYLVANIA

It's Houdry and TCC that are setting the records!

First in Volume—Houdry and TCC units represent nearly two-thirds of the world's total* catalytic cracking capacity and have supplied all but a minor percentage of the United Nations entire war requirements of catalytic aviation fuel.

First in Quality—The highest-octane catalytic cracked aviation base stock being produced anywhere in the world in one pass comes from Houdry-licensed plants.

Houdry licensees will enter the post-war competition for motor fuel markets well armed. The proved efficiency of their processes is enhanced by the sustained engineering support of Houdry Laboratories, which make available improved operating techniques as well as pilot-plant evaluation of crude stocks to assure maximum yields.

* *Includes capacity now serving the war program by improving aviation fuel quality through retreating.*

HOUDRY PROCESS CORPORATION
WILMINGTON, DELAWARE

Houdry Catalytic Processes and the TCC Process are available through the following licensing agents to all American refiners, subject to approval by the United States Government.

BECHTEL-McCONE CORP.
Los Angeles, Calif.

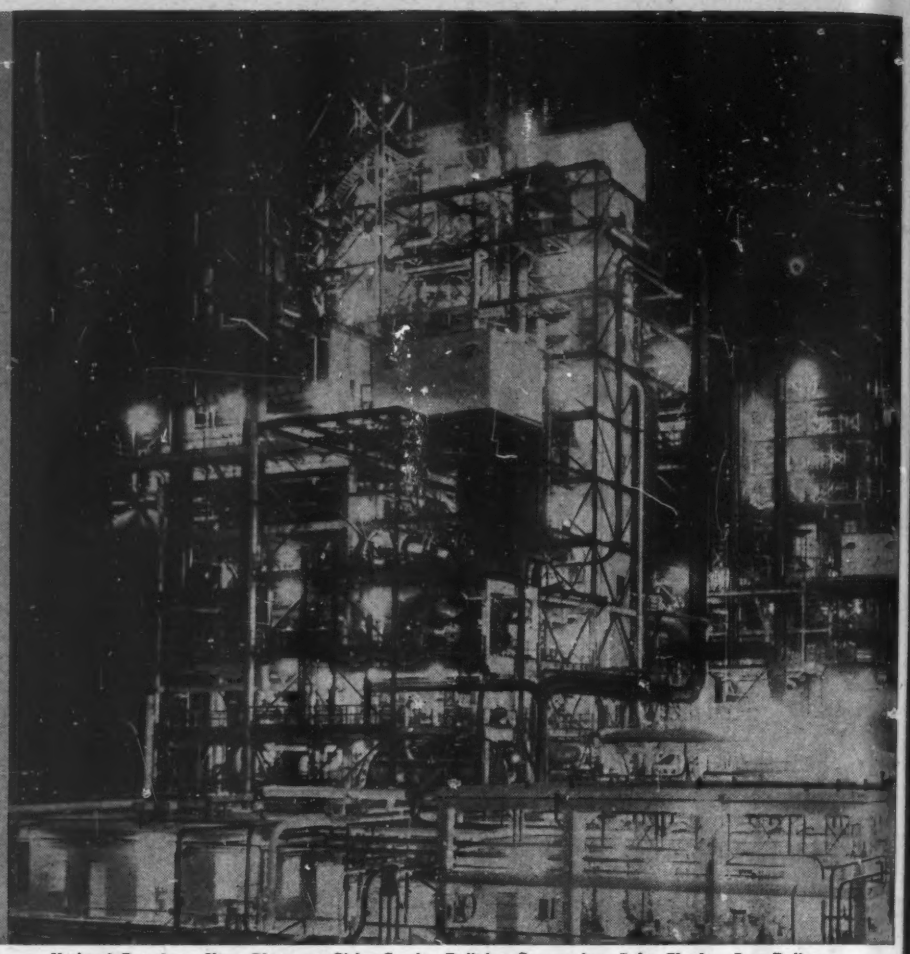
THE LUMMUS COMPANY
New York City, New York

E. B. BADGER & SONS CO.
Boston, Massachusetts

HOUDRY CATALYTIC PROCESSES
FOR VICTORY IN WAR
FOR PROGRESS IN PEACE

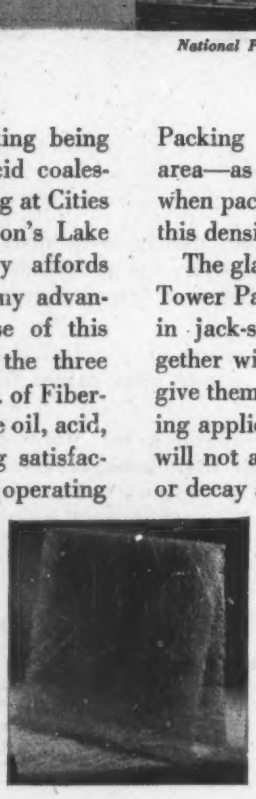
"Hot spot"

HAZARDS ELIMINATED BY FIBERGLAS* TOWER PACKING



National Petroleum News Photo • Cities Service Refining Corporation—Lake Charles, La., Refinery. The M. W. Kellogg Co., Jersey City, N. J.—Engineers-Contractors.

The Fiberglas Tower Packing being used in three horizontal acid coalescers, 3′ 6″ I.D. x 15′ 0″ long at Cities Service Refining Corporation's Lake Charles, Louisiana refinery affords another example of the many advantages derived from the use of this unique material. Each of the three coalescers contains 78 cu. ft. of Fiberglas Tower Packing. Furnace oil, acid, sludge and water are being satisfactorily handled. The units are operating at the required pressure drops and are adequately meeting all specifications.



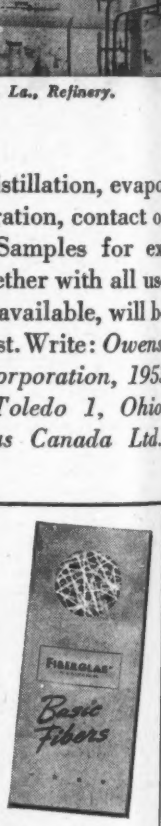
Being made of glass fibers, Fiberglas Tower Packing is incombustible, thus preventing "hot spots". Fiberglas Tower Packing affords exceptional surface area—as much as 232 sq. ft. per cu. ft., when packed at a 6-lb. density. And at this density the free volume is 96.1%.

The glass fibers, of which Fiberglas Tower Packing is made, are arranged in jack-straw manner and held together with a water-soluble binder to give them form for easy handling during application. The individual fibers will not absorb moisture, will not rot or decay and are not affected by most acids. And because of its low cost it is not necessary to clean Fiberglas Tower Packing; simply replace it, easily and quickly, with clean packs.

Perhaps you, too, can benefit by using Fiberglas Tower Packing in your fractionation, distillation, evaporation, diffusion, filtration, contact or eliminator process. Samples for experimental work, together with all use and application data available, will be furnished upon request. Write: *Owens-Corning Fiberglas Corporation, 1953 Nicholas Building, Toledo 1, Ohio. In Canada, Fiberglas Canada Ltd., Oshawa, Ontario.*

Free Samples

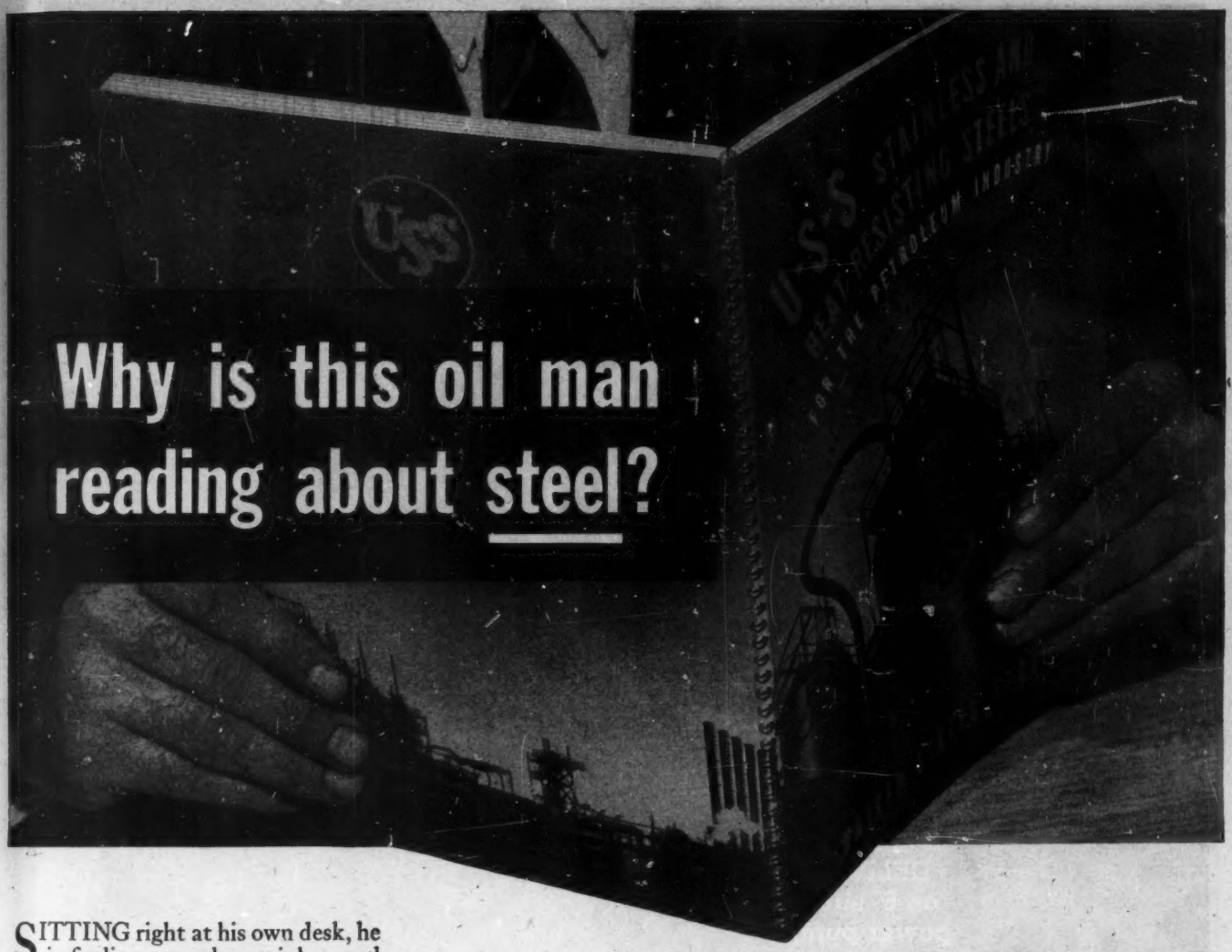
Write for folder containing samples of seven *Fiberglas Basic Fibers* ranging in diameter from .00022" to .0080".



ARMY E NAVY

FIBERGLAS TOWER PACKING

*T. M. Reg. U. S. Pat. Off.



Why is this oil man reading about steel?

SITTING right at his own desk, he is finding out why stainless and heat-resisting steels help hundreds of refiners to boost their output of quality products to new high records and also to cut costs to the bone.

He has long known that different metals have varying success in their conflict with the enemy reagents encountered in processing all grades of crude. He sees now how refinery engineers and our steel specialists—working side by side—developed stainless steel refinery equipment that resists heat, pressure and corrosion, prevents coking and fouling, stays on stream for longer runs, assures more accurate, more rapid fractionation and reduces cleaning time as much as 90%. He realizes that these steels made possible the development of fine big cat crackers that wring the last drop of 100 octane gas out of each barrel of crude.

It will pay you to check up, to make sure that your refinery is taking full advantage of all the qualities of U·S·S Stainless Steel in all its many and varied applications. Here is a quick and easy way to do that.

In our fact-filled, fifty-one page brochure, you will find invaluable engineering, cost and performance data, charts, graphs and explanatory text in your own language. Generously illustrated, with dozens of photographs of actual stainless installations and many drawings, the brochure is yours for the asking.

All you have to do is fill in and mail the convenient coupon — or write to us on your company letterhead — and your copy of "U·S·S Stainless and Heat Resisting Steels for the Petroleum Industry" will be forwarded to you by return mail.

SEND NO MONEY · IT'S FREE!

United States Steel Corporation Subsidiaries
Room 621, Carnegie Building
Pittsburgh 30, Pa.

Dear Sirs:

Please send along my copy of *"U·S·S Stainless and Heat Resisting Steels for the Petroleum Industry"*. It is fully understood that I incur no obligation.

Name.....

Street & Number.....

City..... State.....

P.R. 1243

Steel needs more scrap NOW . . . *send it in!*

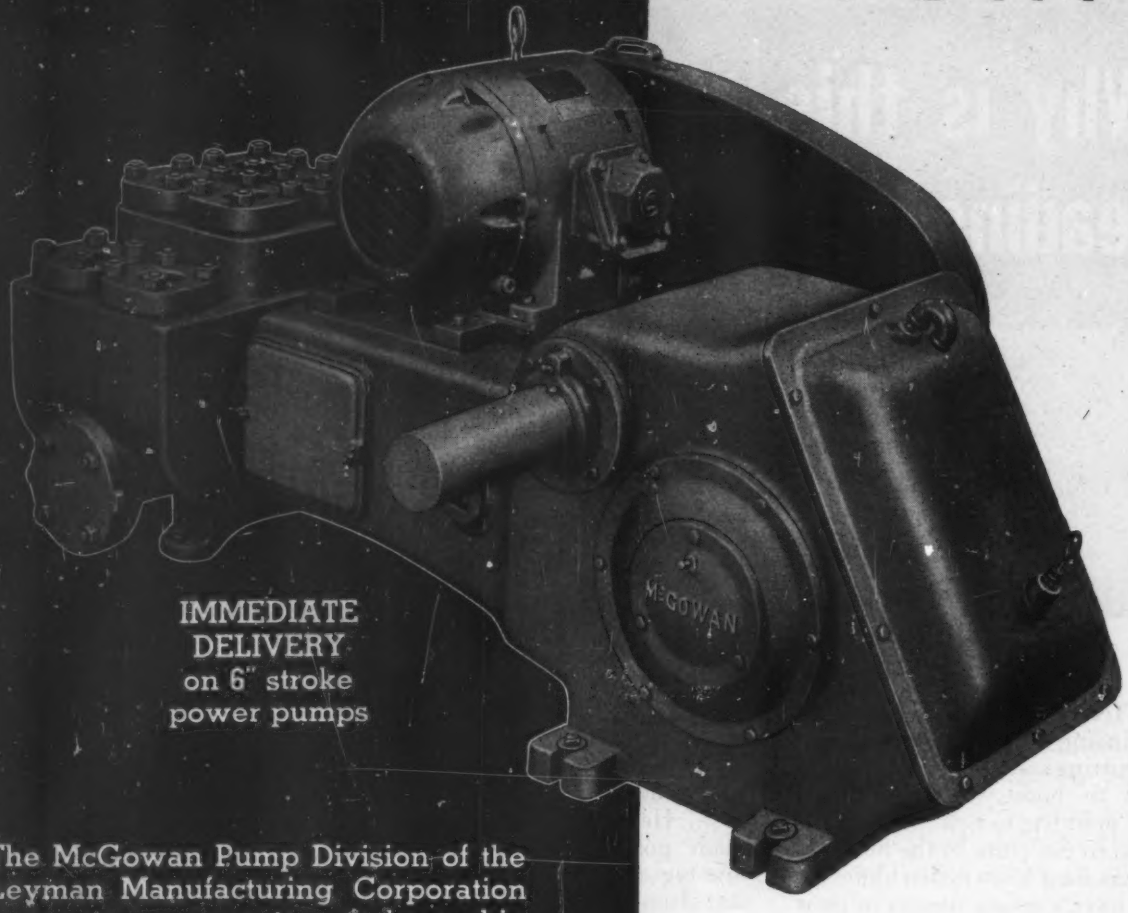
U·S·S Stainless Steel

SHEETS · STRIP · PLATES · BARS · BILLETS · PIPE · TUBES · WIRE · SPECIAL SECTIONS

AMERICAN STEEL & WIRE COMPANY, *Cleveland, Chicago and New York*
CARNEGIE-ILLINOIS STEEL CORPORATION, *Pittsburgh and Chicago*
COLUMBIA STEEL COMPANY, *San Francisco*
NATIONAL TUBE COMPANY, *Pittsburgh*
United States Steel Supply Company, Chicago, *Warehouse Distributors*
United States Steel Export Company, New York

UNITED STATES STEEL

McGOWAN DUPLEX SIDE POT POWER PUMPS



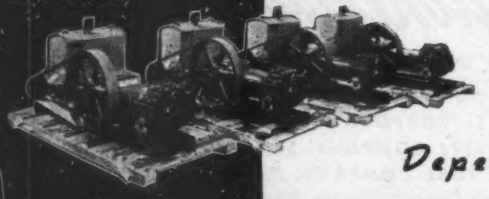
IMMEDIATE DELIVERY on 6" stroke power pumps

The McGowan Pump Division of the Leyman Manufacturing Corporation guarantees accurate workmanship and durable service. An experienced Engineering Department is available for information on installations and requirements. Highly efficient and ruggedly constructed — McGowan Pumps have the ability to stand up year in and year out under severe service conditions.

Write for Catalogue No. 200.

Branch Offices

Boston . . . . . HANcock 3995
New York . . . MUrryhil 2-0786
Philadelphia . . LOmbard 9797
Houston . . . . . FAirfax 8089
Los Angeles . . . VAndk. 1359
New Orleans . . . . CAnal 4851
San Francisco . . EXbrook 1102
Seattle . . . . . CApital 7670
Tulsa 5-2151
Cleveland . . . . . LIberty 2142
Detroit . . . . . MAdison 1575
Charleston, W. Va. 37-606
Salt Lake City 3-4682



Dependable since 1852

McGOWAN PUMPS

LEYMAN MANUFACTURING CORP.
The JOHN H. McGOWAN Co. DIVISION
59 CENTRAL AVE., CINCINNATI 2, OHIO

Seamless Steel Tubing . . .

provides strength for dependable pressure lines

Seamless steel tubing is being given wider and wider acceptance in industry as pressure, fuel and fluid lines. Engineers recognize the added strength embodied in solid steel walls. Other obvious advantages include light weight due to thin walls, freer passage of fluids, easier shaping and resistance to fatigue.

Today Michigan pressure tubing is playing a major role in America's war weapons and on the machines used to produce them. Tomorrow Michigan pressure tubing will fill a wide range of needs in peace-time industry. The many years of experience accumulated by Michigan Seamless Tube company are at your disposal.

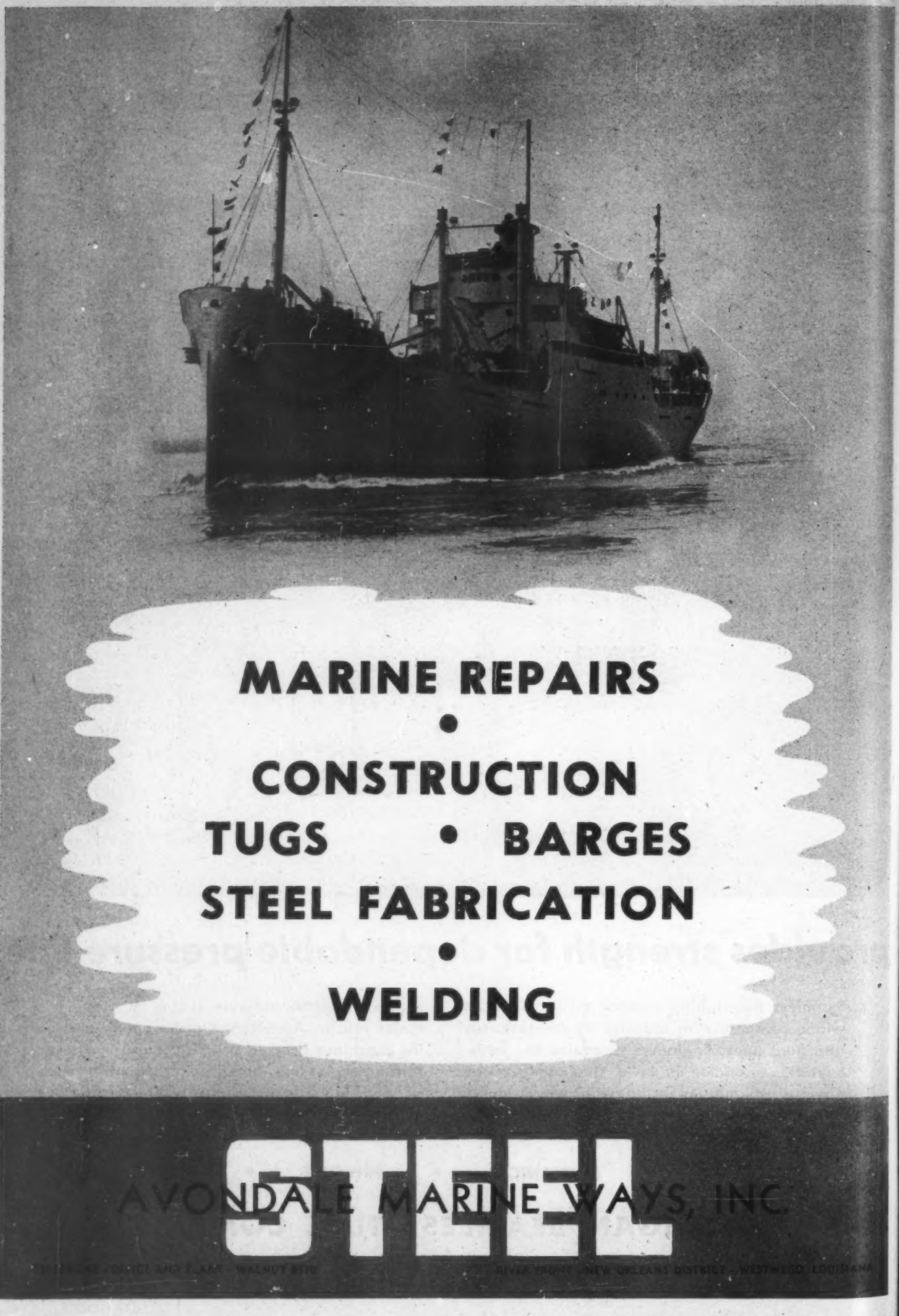
AIRCRAFT • MECHANICAL • PRESSURE • STRUCTURAL

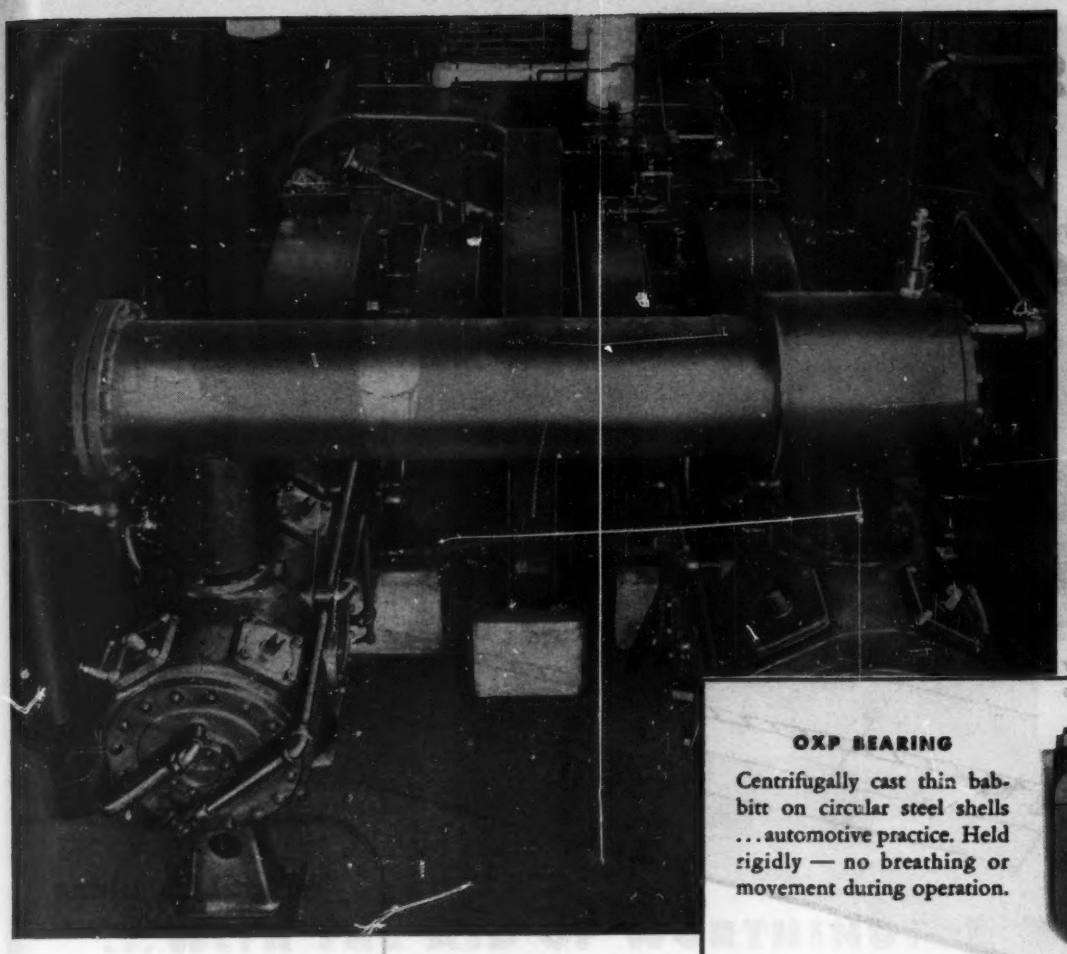
MICHIGAN SEAMLESS TUBE COMPANY

SOUTH LYON • MICHIGAN

ARMY E NAVY

Awarded Feb. 12, 1943
First Star Sept. 9, 1943
Second Star May 27, 1944

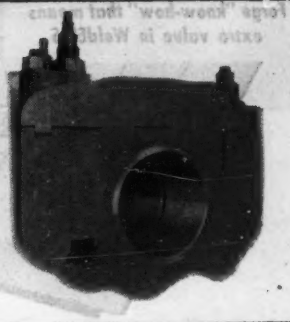

MARINE REPAIRS
•
CONSTRUCTION
TUGS • BARGES
STEEL FABRICATION
•
WELDING
STEEL
AVONDALE MARINE WAYS, INC.



A Worthington OXP$_2$ Feather Valve Compressor as installed by a large manufacturer of metal products.

OXP BEARING

Centrifugally cast thin babbitt on circular steel shells . . . automotive practice. Held rigidly — no breathing or movement during operation.



PLAIN TALKS with a Worthington engineer will help you get the most from that big, heavy-duty compressor installation you have in mind. •

For more than 40 years, Worthington has accumulated data on the application of compressors to the air and gas compression problems of power plants . . . refineries . . . manufacturing industries from coast to coast. •

Write for "Plain Talks on Air and Gas Compression", a factual, practical series of articles by Worthington engineers. *Consult* with a Worthington specialist in planning your next compressor installation . . . his experience is available to you without cost or obligation. *Worthington Pump and Machinery Corporation, Buffalo Compressor Division, Buffalo, N. Y.*

5 Other Reasons for More Worth in this Heavy-Duty Worthington

1. ***Bronze Type Inter-Cooler Tubes*** — lowest power consumption.
2. ***Balanced-Piston Steam Valves***—high steam pressures and temperatures provide best steam economy.
3. ***Full Force Feed Lubrication***—only a Worthington steamer gives you this decided advantage.
4. ***Class "30" Automatic Governor*** — the positive, sensitive, simplest method of regulating compressor by automatically changing steam cut-off . . . with improved steam economy.
5. ***Smooth, Balanced Operation***—heavily counter-balanced cranks reduce vibration and operation strains.

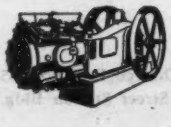
WORTH BEHIND THE NAME WORTHINGTON

AC4-18

NO OTHER COMPRESSOR WILL OUTPERFORM A WORTHINGTON

Y-types

Horizontal

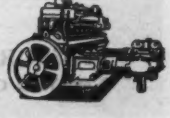


Vertical

Radial

Portable

Gas Engine Compressors



FUSSY PEOPLE, THESE!

Another example of Taylor Forge "know-how" that means extra value in WeldELLS

★ *Two Taylor Forge Carbon-Moly Tees with a 5½" nipple welded between them would have provided an assembly with the same overall dimensions as the special "tandem outlet" 5x5x2½x2½" seamless carbon-moly tee pictured here. But this was a particularly "fussy" job with so much at stake that the engineers wanted this exact fitting.*

Quite naturally, this job wound up at Taylor Forge; for engineers throughout America have learned that the meticulous jobs—those which call for unusual skill and knowledge in the forming of hot metals—are expertly handled here.

MOST people know of Taylor Forge's reputation for doing the unusual —sometimes even the "impossible". But the important thing to recognize is that the very same factors which built this reputation also provide many extra values in our standard, stock welding fittings . . . that this ability to make difficult "specials" is reflected in the design of our regular line of WeldELLS and other Taylor Forge fittings.

That is why you find in WeldELLS a combination of features that is not incorporated in any other make. There are sound reasons for everyone of them, and the overall result is a stronger, longer lasting and . . . more *economical* piping job.

Just check the list of features opposite and we believe you'll fully agree that

WeldELLS have everything

WeldELLS alone combine these features:

- **Seamless**—greater strength and uniformity.
- **Tangents**—keep weld away from zone of highest stress—simplify lining up.
- **Precision quarter-marked ends**—simplify layout and help insure accuracy.
- **Selective reinforcement**—provides uniform strength.
- **Permanent and complete identification marking**—saves time and eliminates errors in shop and field.
- **Wall thickness never less than specification minimum**—assures full strength and long life.
- **Machine tool beveled ends**—provides best welding surface and accurate bevel and land.
- **The most complete line of Welding Fittings and Forged Steel Flanges in the World**—insures complete service and undivided responsibility.

TAYLOR FORGE & PIPE WORKS, General Offices & Works: Chicago, P. O. Box 485
New York Office: 50 Church Street • Philadelphia Office: Broad Street Station Bldg.

. . . WITH THE AID OF WORTHINGTON PUMPS

Oil that comes up in Texas makes it possible for bombardiers to drop destruction squarely on Berlin. And all along the line—from petroleum field . . . to refinery . . . to tank farms or shipping terminal . . . to bombers — many types of Worthington Centrifugal Pumps are on the job.

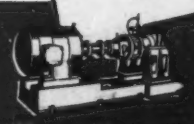
And speaking of diversity, Worthington offers the *broadest* line of centrifugal pumps for petroleum industries . . . the only *complete* line of chemical pumps for the corrosive services . . . and the world's greatest wealth of pump application "know-how".

On the basis of the experience gained in solving past and present pump engineering and application problems, Worthington is better prepared to provide the pump engineering required for the new processes ahead. Get in touch with our nearest District Office. *Worthington Pump and Machinery Corporation, Centrifugal Pump Division, Harrison, New Jersey.*

THE WORLD'S LARGEST MANUFACTURER OF PUMPS

WORTHINGTON BEHIND THE NAME WORTHINGTON

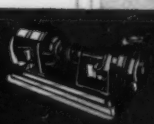
CP4-30



Types HR and HB. Twenty sizes. Capacities up to 1800 g.p.m. Developed heads up to 900 ft. Proper selection of material permits use for temperatures far below zero to 1800°F., for pressures from high vacuum to 750 lb. per sq. in. gauge.

Type HD. Hydraulically-balanced, double-suction impeller handles boiling liquids with low submergence. Capacities range from 600 to 3200 g.p.m. at heads up to 700 ft., temperatures up to 850°F., pressures up to 550 lb.

Type WH. High pressure, high-temperature, centrifugal hot-charge pumps. Twelve distinct points of superiority, based on years of experience building pumps for high pressures and temperatures. Capacities to 2000 g.p.m., heads to 5000 ft.



Type HL. Several construction arrangements permit flexibility in application. Designed for temperatures up to 225°F. or higher with water-jacketed stuffing box. Capacities up to 1600 g.p.m., heads to 500 ft.

Tank Fittings
FOR ALL TYPES OF STORAGE

Part of the storage facilities of the Houston Butadiene plant operated by Sinclair Rubber, Inc.

In the vast petroleum and petro-chemical industries, storage vessels of all conceivable shapes and sizes are in service. There are the conventional atmospheric or low pressure refinery storage tanks everyone knows. Then there are the newer spheres, spheroids, and "bullets" operating at medium and high pressures. No matter what the design or dimensions of the storage tank or the pressure under which it operates, there are S. & J. Fittings for the regulation of pressures, accurate measurement, conservation, and safe handling. When you contemplate new storage or the modernizing of existing tanks, S. & J. will appreciate your inquiries for regular or special equipment.

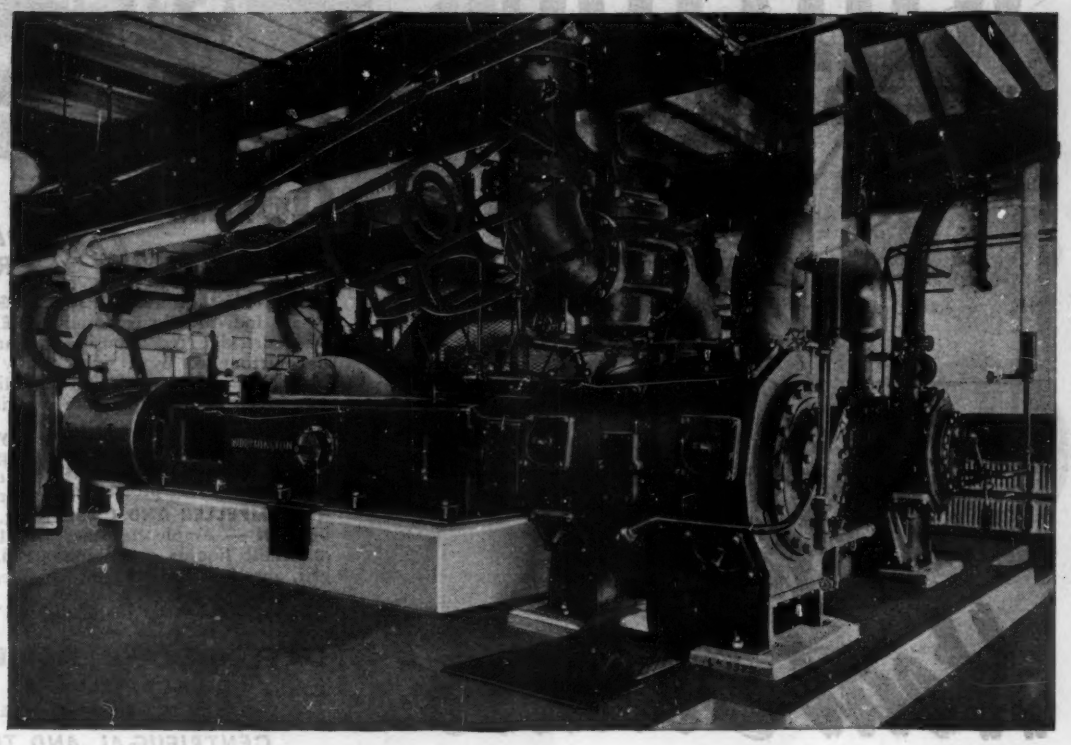
SHAND & JURS CO.

BERKELEY, CALIFORNIA

NEW YORK CHICAGO HOUSTON LOS ANGELES SEATTLE

SHAND & JURS

WHEN TO OMIT INTERCOOLERS?



Worthington Model OXP 600 hp., compound 2-stage, opposed, steam-driven compressor, as installed without intercooler in refinery service.

THERE are two reasons why it is frequently desirable to omit intercoolers on two-stage gas compressors . . . both of which are discussed in "Plain Talks on Air and Gas Compression", No. 4, written by Worthington engineers.

The first is the relatively smaller rise in temperature during compression of hydrocarbon gases with a low "N" value.

The second is the relatively lower condensation temperature of such gases with increased pressure developed within the compressor cylinders. If these gases are not maintained at temperatures safely above the saturation point, precipitation may be injurious or dangerous.

Analysis of problems such as this is part of the daily work of Worthington engineers and forms the subject matter of "Plain Talks", a continuing series.

Backed by the most thorough knowledge of gas compression in the industry, Worthington engineers are best able to advise you on your next compressor installation. ***Worthington Pump and Machinery Corporation, Buffalo Compressor Division, Buffalo, N. Y.***

GC4-8

NO OTHER COMPRESSOR WILL OUTPERFORM A WORTHINGTON

BEHIND THE NAME WORTHINGTON

WHITLOCK

HEAT TRANSFER EQUIPMENT

Makes Heat Behave

Whitlock Heat Transfer Equipment has been "making heat behave" for over fifty years. Our extensive background in the design and construction of heat exchangers enables us to build dependability and efficiency into every Whitlock unit for the refinery field: **heat exchangers, reboilers, vapor condensers, coolers, coils, pressure vessels, prefabricated piping, etc.** Let us know your requirements.

Send for your copy of
"Care and Handling of Heat Exchangers"

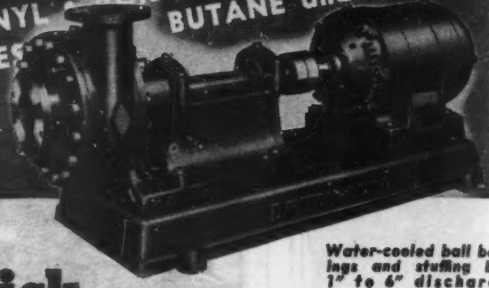
The WHITLOCK MANUFACTURING COMPANY

75 SOUTH STREET, ELMWOOD, HARTFORD 1, CONN.
New York Boston Chicago Philadelphia Detroit Richmond

Authorized representatives in other principal cities

***In Canada:* Darling Brothers, Ltd., Montreal**

For pumping
OILS • DOWTHERM
DIPHENYL • ACIDS • GASOLINE
SLUDGES BUTANE and PROPANE



Water-cooled ball bearings and stuffing box. 1" to 6" discharge

Quick Facts *about* DAYTON-DOWD PROCESS PUMPS

WATER-COOLED BEARINGS — are individually enclosed in a cartridge type housing and surrounded by a water jacket for cool, smooth running when high temperature liquids are handled.

WATER-COOLED STUFFING BOX — surrounds eight rows of packing. Extra protection.

NEW IMPELLER AND CASE DESIGN — Ample clearance to handle liquids containing grit, abrasives and sludges.

HIGH HYDRAULIC EFFICIENCY — Inherent design characteristics develop unusually high operating efficiency. Reliable operation at low maintenance cost.

Dayton - Dowd single - stage, single - suction pumps provide easy accessibility to all working parts. Only the casing, two side plates and impeller comprise the pump-end. Available with either *open* or *enclosed* impellers.

Write today for Bulletin No. 810.

DAYTON-DOWD COMPANY
QUINCY, ILLINOIS
OFFICES IN PRINCIPAL CITIES

CENTRIFUGAL AND TURBINE PUMPS

ACCURATE LIQUID LEVEL INFORMATION AT A GLANCE, WHEN YOU WANT IT—

WITH

LIQUIDOMETER *Tank Gauges*

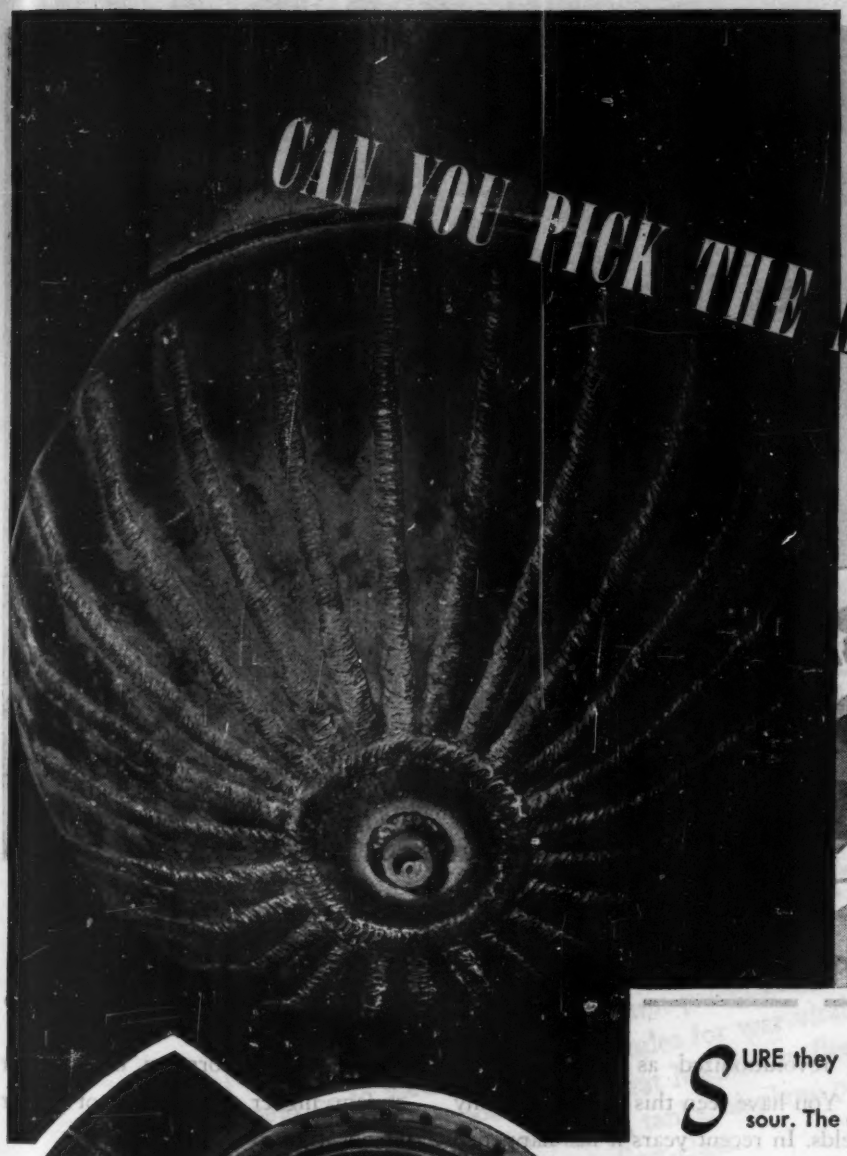
"THEY'RE ALWAYS DEPENDABLE"

100% automatic.
No pumps, valves, or auxiliary units needed to read them.
Models available for either remote or direct readings.
Accuracy unaffected by specific gravity of tank liquid.
Approved by Underwriters' Laboratories for gauging hazardous liquids.

Write for complete details.

THE LIQUIDOMETER CORP.
39-14 SKILLMAN AVE., LONG ISLAND CITY, N.Y.

CAN YOU PICK THE BETTER ORANGE?



SURE they *look* alike, but—one is sweet, the other sour. The quality depends on *where it's from.*

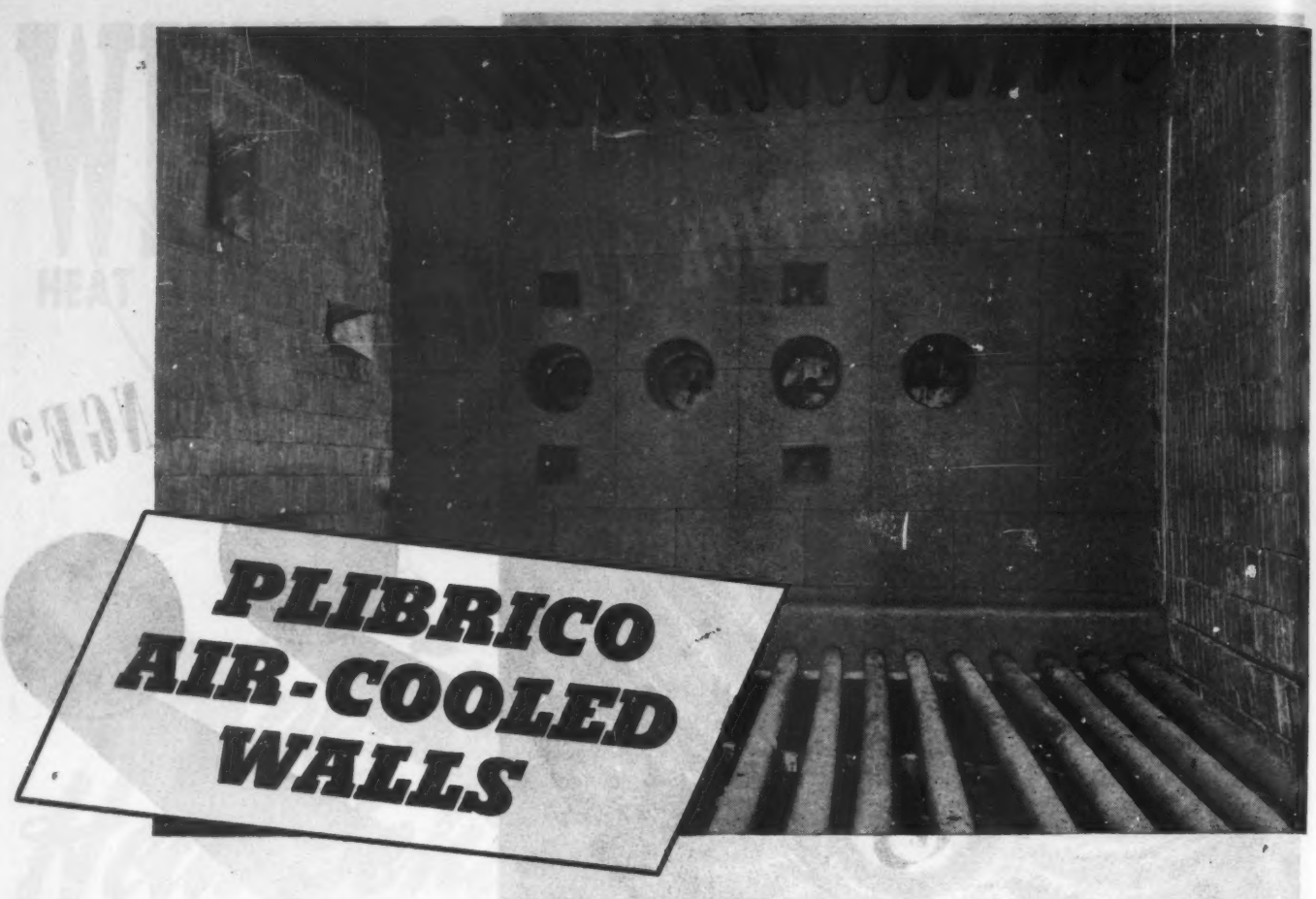
That's just as true of welding. Though two jobs *look* alike, one may turn out to be pretty "sour."

You can be sure of a "sweet" weld from Flori every time because our welding procedures are accepted by the Hartford Steam Boiler Inspection and Insurance Company and performed by code-qualified welders for Metallic Arc Welding in accordance with ASME Power Boiler Code. Each of our operators is a master in the art of pressure welding.

IF IT'S FABRICATION . . . CONTACT FLORI.

FLORI FABRICATION

THE FLORI PIPE COMPANY • ST. LOUIS 15 • CHICAGO 47



PLIBRICO AIR-COOLED WALLS

They accomplish more—but they cost less!

The development of all equipment follows a pattern that is well known to operating men. It goes along the same old road year after year with only minor improvements. Then someone suddenly puts a finger on the right spot and the whole scheme is revolutionized as if over night.

You have seen this happen in many fields. In recent years it has happened in refractory linings for oil stills. Plibrico air-cooled walls for oil stills combine the two attributes that can truthfully be called revolutionary: They *accomplish more,* but *cost less.*

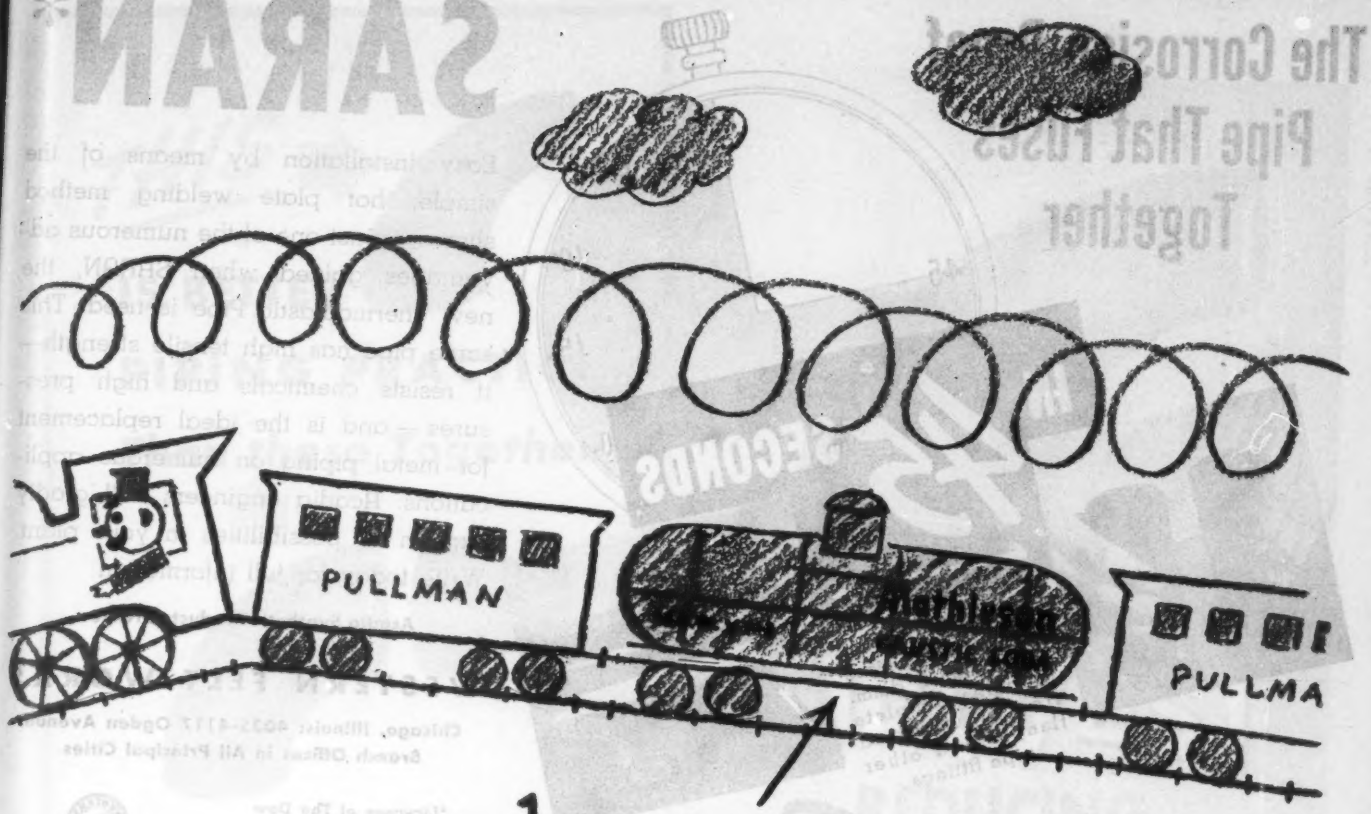
They accomplish more because their basic construction absolutely prevents appreciable air leakage. The Plibrico lining eliminates the innumerable joints found in tile walls, and to make air tightness doubly sure a corrugated steel sheet is used to back up the Plibrico wall. The resulting prevention of infiltration contributes greatly to combustion efficiency, and a further gain in efficiency is attained by the narrow air lanes—only 4" wide—which produce higher air velocities; greater heat absorption into the air stream; higher temperature of air for combustion.

Plibrico air-cooled walls cost less to build and less to maintain—less to build because they require no elaborate steel work, heavy castings, or special tiles—less to maintain because Plibrico is more substantial to start with and because it is so readily and satisfactorily used (in plastic form) to fix spots needing attention regardless of position or contour.

This better, lower cost lining is available at once from stocks throughout the oil country. Complete service is available for building, rebuilding or repairing. If desired, your own men can install Plibrico under our supervision. Send blueprints for specific recommendations.

Note bracket-like Taperlok supports which sectionalize the lining and transfer load to outer brickwork; also patented Flexo-Anchors which positively prevent bulging. Corrugated sheet gives extra protection against air leakage.

PLIBRICO JOINTLESS FIREBRICK CO.
1803 Kingsbury St., (Dept. L), Chicago 14, Illinois



it hasn't happened yet.

NO, we haven't yet had to attempt passenger train service to meet delivery schedules for war-vital Mathieson Caustic Soda. The great Mathieson fleet of tank cars rides the rails with guns, tanks, airplane parts—definitely travels first-class.

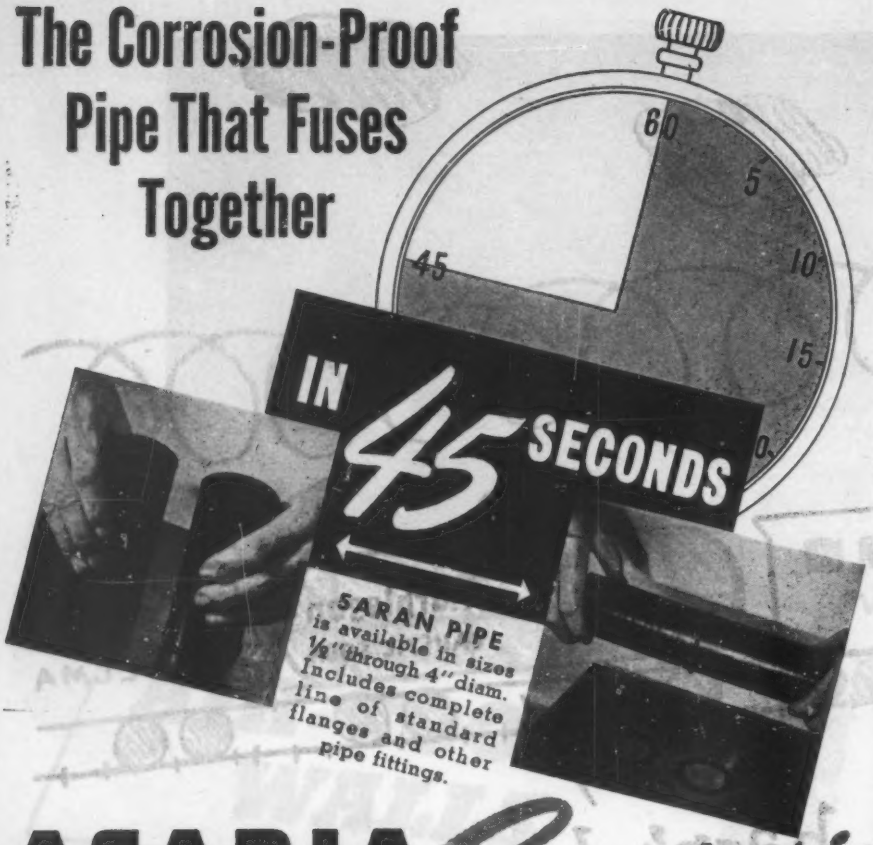
And no Pullman car is more carefully groomed between trips than a Mathieson Liquid Caustic tank car. Each is minutely inspected and cleaned at our own car shops—checked to assure fast delivery of clean, pure caustic for the thousand-fold job it does to speed Victory. Yes—because of the grand job the railroads are doing to move war supplies and Mathieson's attention to important details—it's first-class transportation for a top-class product!

Mathieson
CHEMICALS

THE MATHIESON ALKALI WORKS (INC.) 60 EAST 42nd STREET, NEW YORK 17, N. Y.

CAUSTIC SODA . . SODA ASH . . BICARBONATE OF SODA . . LIQUID CHLORINE . . BLEACHING POWDER . . H T H PRODUCTS . . AMMONIA, ANHYDROUS & AQUA . . FUSED ALKALI PRODUCTS . . SYNTHETIC SALT CAKE . . DRY ICE . . CARBONIC GAS . . SODIUM CHLORITE PRODUCTS . . SODIUM METHYLATE

The Corrosion-Proof Pipe That Fuses Together


IN 45 SECONDS
SARAN PIPE is available in sizes ½" through 4" diam. Includes complete line of standard flanges and other pipe fittings.

SARAN*

Easy installation by means of the simple, hot plate welding method shown, is just one of the numerous advantages gained when SARAN, the new Thermoplastic Pipe is used. This same pipe has high tensile strength—it resists chemicals and high pressures—and is the ideal replacement for metal piping on numerous applications. Acadia engineers will gladly explain its possibilities in your plant. Write today for full information.

Acadia Synthetic Products Division

WESTERN FELT WORKS

Chicago, Illinois: 4035-4117 Ogden Avenue
Branch Offices in All Principal Cities

*Licensee of The Dow Chemical Company

ACADIA Synthetic PRODUCTS

Processors of Synthetic Rubber and Plastics
Sheets • Extrusions • Molded Parts

Largest Independent Manufacturers and Cutters of Wool, Hair and Jute Felts.

MURRAY GEARED TURBINES

Type UG

For best efficiency, your fan or pump may need a geared steam turbine. The gear may be separate or in the smaller sizes integral with the turbine. For smooth and quiet operation turbine units must be properly aligned from the start, and integral turbine gear units are no exception. The standard centerline support and rugged construction of Murray Type U turbines, combined with single or double helical gears, vertically offset, result in compact smooth running machines.

The excess piping shown is for gland seal for condensing operation.

MURRAY STEAM TURBINES
10 HP to 2500 KW rating

Sales Offices in all principal cities

MURRAY IRON WORKS COMPANY

BURLINGTON, IOWA

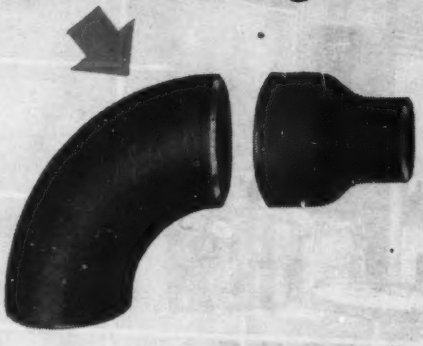
BUILDERS OF STEAM POWER EQUIPMENT FOR THREE QUARTERS OF A CENTURY

THIS →

IS BETTER

PIPING PRACTICE

Than these Together



Why make three welds when two will produce a better piping job? Where it is necessary to change both the direction of flow and size of pipe, the Midwest Reducing Elbow replaces two welding fittings: (1) a standard elbow and (2) a reducer. The many important features are enumerated at the right.

All the advantages of Midwest Standard Elbows are to be found in Midwest Reducing Elbows: unusual dimensional accuracy and uniformity, beneficial effect of working metal in compression, stress relieving, etc. Center-to-end dimensions are the same as in standard elbows with which they are interchangeable.

The Reducing Elbow is only one of the many Midwest developments designed to improve the quality of welded piping and to save cost in erection. Write for Bulletin WF-41 for complete information about the advantages of Midwest Welding Fittings.

MIDWEST

REDUCING WELDING ELBOW

Eliminates One Weld
Cuts Installation Costs
Saves Time
Reduces Turbulence
Improves Appearance

MIDWEST

WELDING FITTINGS IMPROVE DESIGN AND REDUCE PIPING COSTS

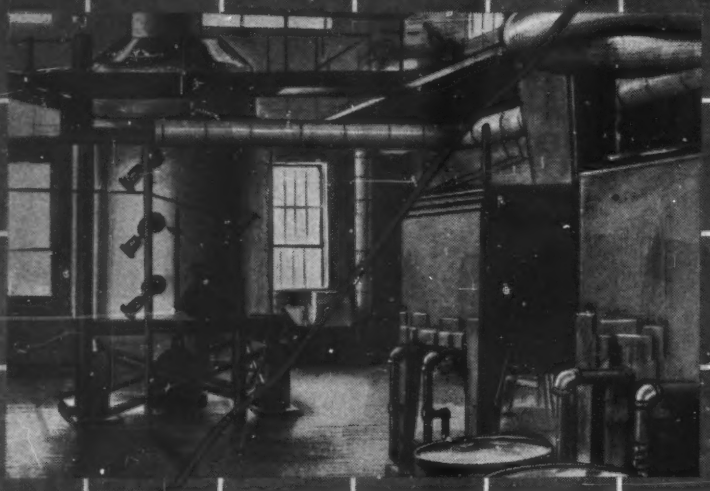
MIDWEST

PIPING & SUPPLY COMPANY, INC.

Main Office: 1450 South Second St., St. Louis 4, Mo.

Sales Offices: New York 7—(Eastern Division) 30 Church St. • Chicago 3—645 Marquette Bldg. • Los Angeles 33—520 Anderson St. • Houston 2—229 Shell Bldg. • Tulsa 3—533 Mayo Bldg. • Atlanta 3—Red Rock Bldg. • South Boston 27—426 First St. • Distributors in Many Cities

Dowtherm on the job!



INSTALLED IN 1934

Efficiency Up—Costs Down

Ten years ago Dowtherm was a new development. Among the Dowtherm installations made at that time was one in the plant of a Midwestern oil processor. Prior to his adoption of the efficient Dowtherm heat transfer method, this producer of specialty oils had used a direct-fired system, with resultant shutdowns caused by burned-out kettle bottoms, charring and "coking-up" of the material, and even a costly plant fire.

But with Dowtherm on the job, this processor reports the saving of time . . . simplification of operation . . . highly accurate heat control, with changes rapidly effected when needed . . . complete elimination of forced shutdowns . . . and a reduction of 50% in operating costs.

This is actual experience; and it is *typical* among today's 400 Dowtherm users. If your operations involve the precise control of temperatures within the 400°-725° F. range . . . if you are looking for freedom from the dangers of high pressures . . . for production without interruption . . . for uniformity of product and the possibility of product improvement . . . for new substantial economies . . . then Dowtherm should have your attention. Dow is readily at your service with detailed data on Dowtherm liquid and Dowtherm vapor systems.

THE DOW CHEMICAL COMPANY
MIDLAND, MICHIGAN

New York • Boston • Philadelphia • Washington • Cleveland • Detroit
Chicago • St. Louis • Houston • San Francisco • Los Angeles • Seattle

Dowtherm

The high-temperature, low-pressure heat transfer medium

DOW
CHEMICALS INDISPENSABLE TO INDUSTRY AND VICTORY

DESIGNED... ENGINEERED... CONSTRUCTED BY McKEE

• The photo above shows a new Aviation Gasoline plant under construction. This is one of many modern plants for scientific refining processes designed, engineered and constructed by Arthur G. McKee & Company.

Arthur G. McKee & Company

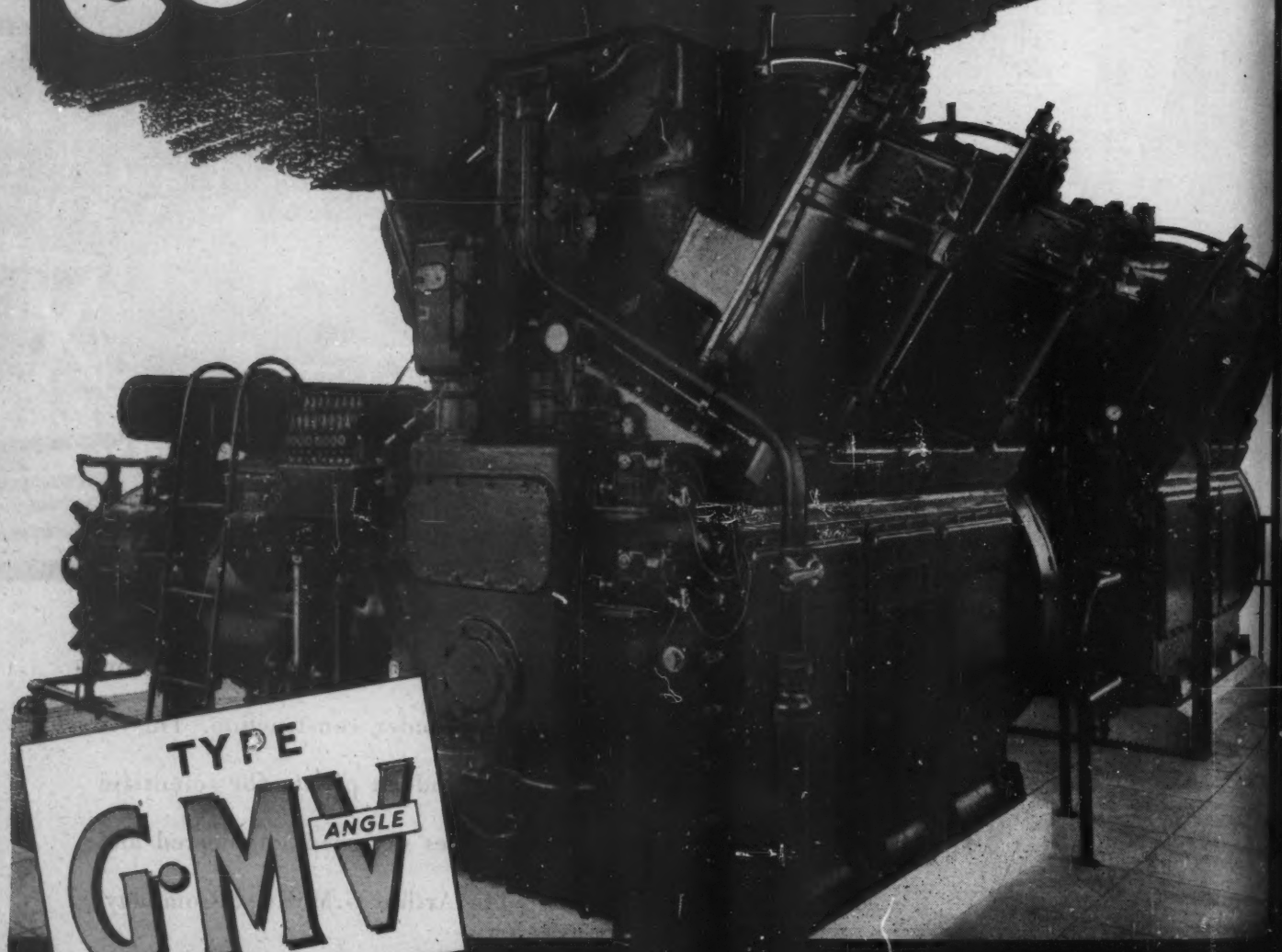
★ *Engineers and Contractors* ★

2300 CHESTER AVENUE • CLEVELAND, OHIO

30 Rockefeller Plaza
New York, N. Y.

Commerce Building
Houston, Texas

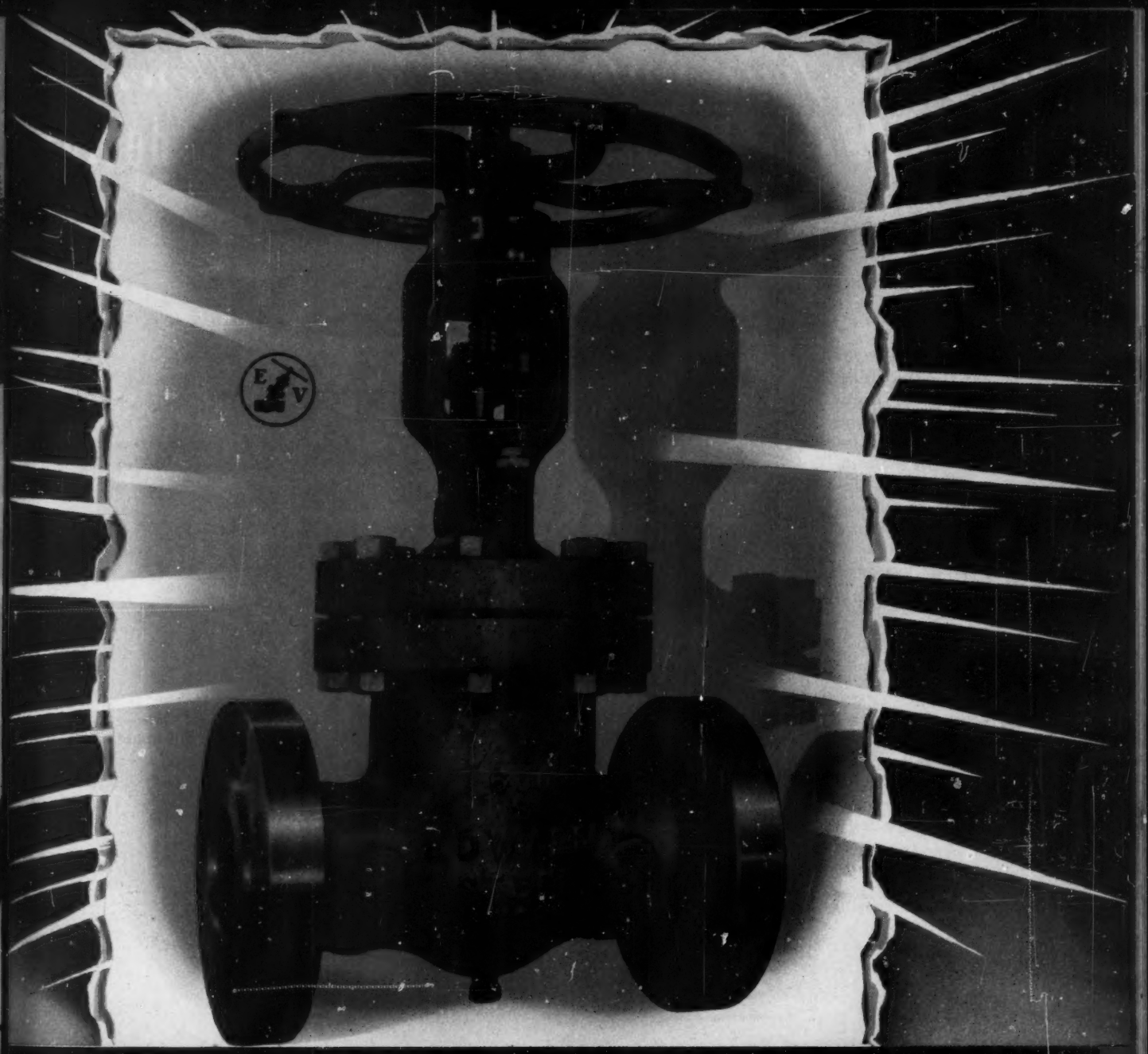
RUGGED CONSTRUCTION



TYPE G·MV ANGLE

Compressors

New York Washington Bradford, Pa. Parkersburg, W. Va. San Francisco, Cal. Seattle, Wash.



Basically different in design,

here is a GATE VALVE *with all*

working parts in correct alignment.

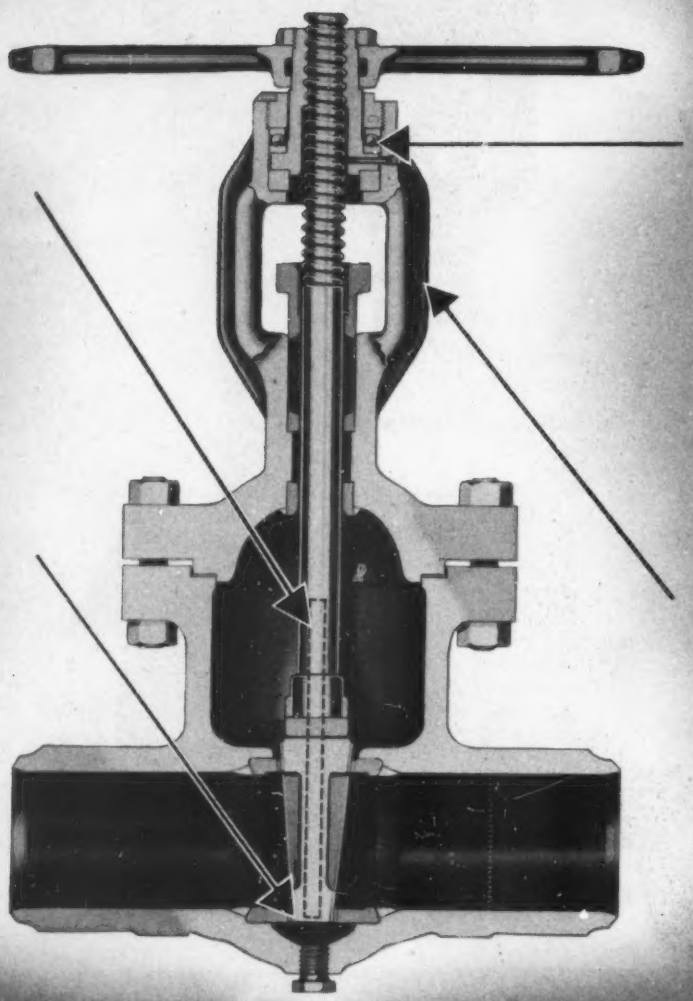
New by **EDWARD**

WRITE FOR CATALOG 42-E

Here are four important basic differences in **EDWARD** *cast steel* GATE VALVE design

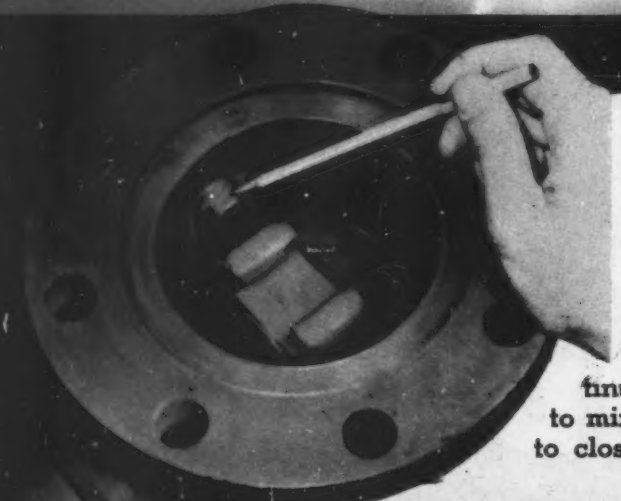
1 Close fitting hardened wedge guides welded to body *after* seat rings and wedge are located. The result—perfect alignment of working parts and elimination of unnecessary wear-producing drag of wedge across seating faces in opening and closing valve under pressure.

2 Correctly positioned hard surfaced seats, integral with body, and hard faced wedges. Standard construction—*not a "special" which must be ordered.*



3 Simple yoke construction with ball bearing operation even in medium sizes, EValized surfaces where abrasion is a problem, and no superfluous parts.

4 One piece bonnet for absolute alignment, easy operation and minimized maintenance.



No wobbly wedges to cause excessive seating wear or slam against stem head when opened under pressure in Edward gate valves. In contrast with traditional gate valve design, guide ribs in Edward gate valves are accurately located with respect to seat faces and wedge, then welded integrally to body with continuous weld fillets. Clearances are thus cut to minimum and wedge can travel practically to closed position before seating faces touch.

THE EDWARD VALVE & MFG. CO., INC.
EAST CHICAGO INDIANA

45% of 99.8 RESEARCH OCTANE with FLUID CATALYTIC CRACKING

Foster Wheeler designs and builds Fluid Units . . . today producing aviation gasoline for war and tomorrow a motor fuel component of 95 and higher Research Octane without lead.

FOSTER WHEELER CORPORATION
165 BROADWAY • NEW YORK 6, N. Y.

WHEELER

Furfural

IS READILY AVAILABLE

for your

SELECTIVE REFINING

Furfural for the refining of petroleum oils is readily available. (While still under allocation, all requirements are being supplied.) All you need can be shipped in tank car quantities, enabling you to produce the superior lubricants that the Furfural Refining Process yields.

A Simple, Safe Operation

The Furfural Process is simple. It is easy to control and economical in operation. 99.95% or higher recovery of Furfural per cycle is averaged. It is safe. There are no toxic effects and no special precautions are required.

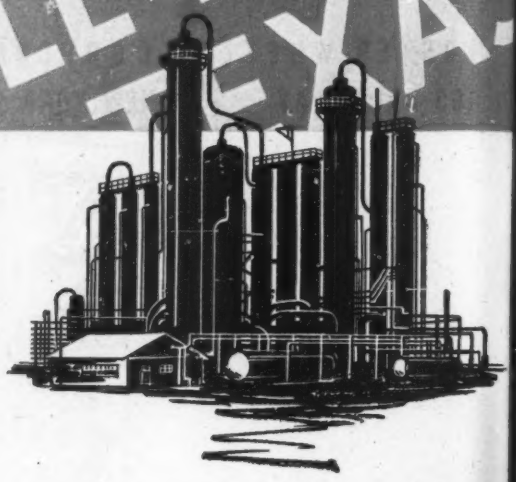
Low Cost

Furfural of Oil Refining Grade is available at 9½c per pound FOB Cedar Rapids, Iowa. This low price plus the high recovery per cycle make its use especially economical.

Stability

The high percentage of recovery and the experience of eighteen refineries over a period of eleven years testify to the chemical stability of Furfural. Its thermal stability is shown by the fact that it can be repeatedly cycled at temperatures in excess of 400° F. with little evidence of decomposition.

If you have been debating the question of Furfural Refining, now is the time to take positive action. *Write:*



BACKGROUND OF EXPERIENCE

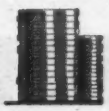
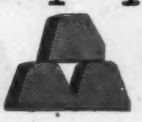
Since 1933 when the first Furfural Refining installation was made, the use of Furfural for refining purposes has increased steadily. Prior to the war, more Furfural Refining installations for the refining of lube oil were in use than any other solvent extraction process. During the war period more Furfural installations have been made than for any other process. *More barrels* of lubricating oil are refined by the Furfural process than by any other single process. The continually increasing list of names includes Continental Oil Company, Gulf Oil Corporation, Magnolia Petroleum Company, Quaker State Oil Refining Corporation, Shell Oil Company, The Texas Company, etc.

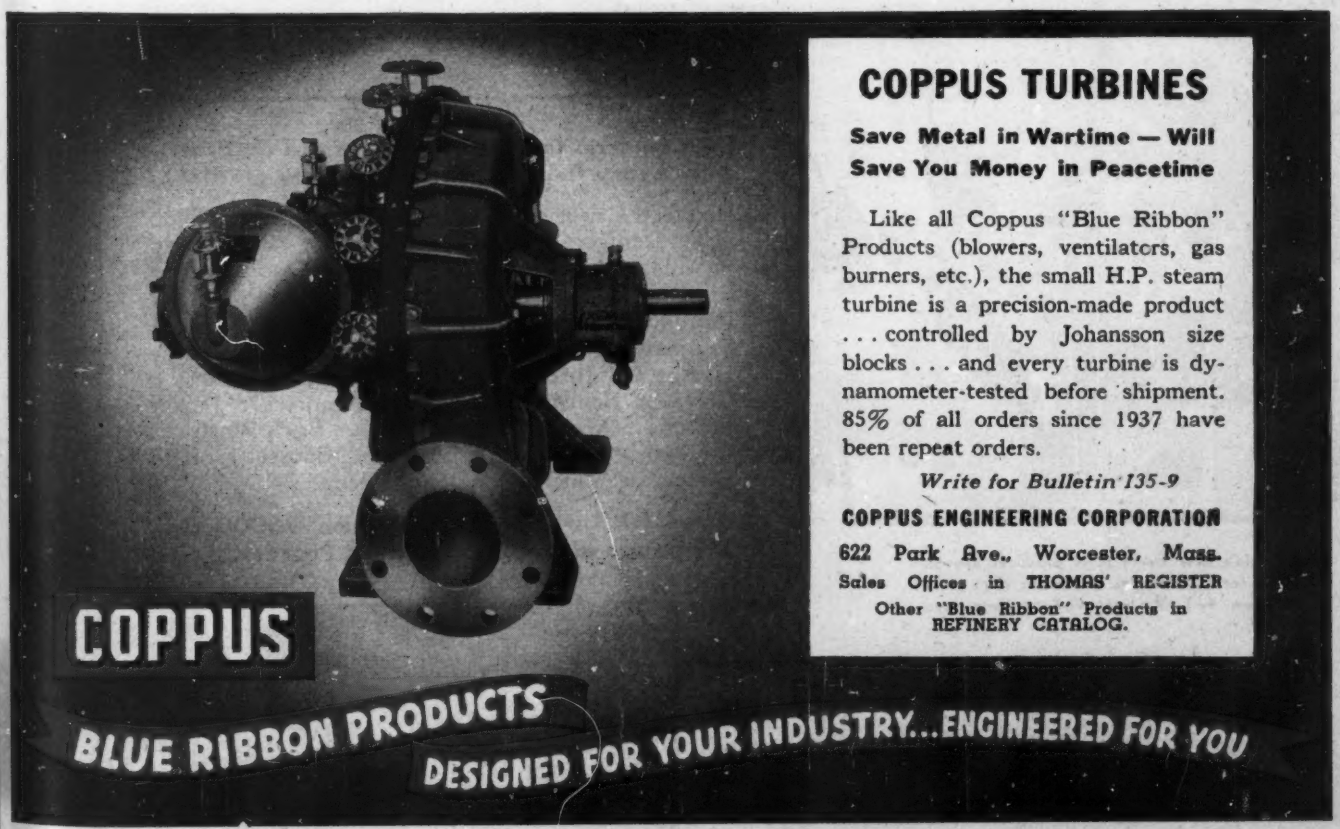
The Quaker Oats Company

CHEMICALS DEPT.

1850 BOARD OF TRADES BLDG., 141 W. JACKSON BOULEVARD • CHICAGO 4, ILL.

FURFURAL • FURFURYL ALCOHOL • HYDROFURAMIDE • TETRAHYDROFURFURYL ALCOHOL

A steam turbine needs a big frame to develop Elephant Power . But if you need only Horsepower, a **COPPUS** Steam Turbine saves money and metal . Six sizes from 150 Horsepower down to fractional. Each smaller size has smaller frame requires less metal and is priced less . Each is a COPPUS Blue Ribbon Turbine so you get top quality while saving money  and metal  .



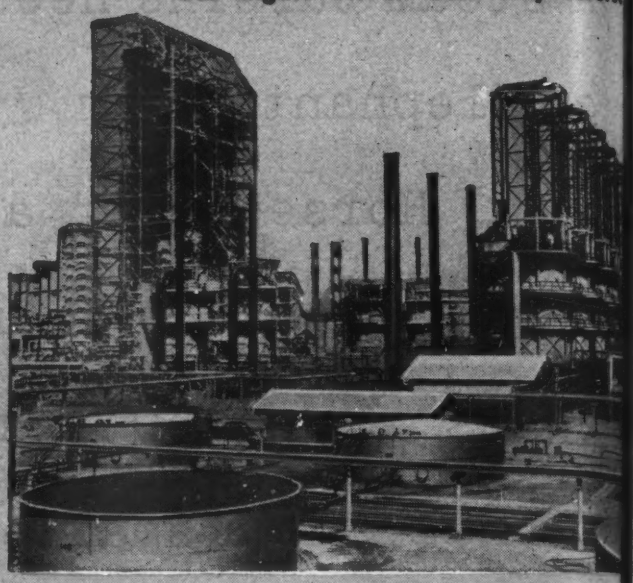
COPPUS TURBINES

Save Metal in Wartime — Will Save You Money in Peacetime

Like all Coppus "Blue Ribbon" Products (blowers, ventilators, gas burners, etc.), the small H.P. steam turbine is a precision-made product . . . controlled by Johansson size blocks . . . and every turbine is dynamometer-tested before shipment. 85% of all orders since 1937 have been repeat orders.

Write for Bulletin 135-9

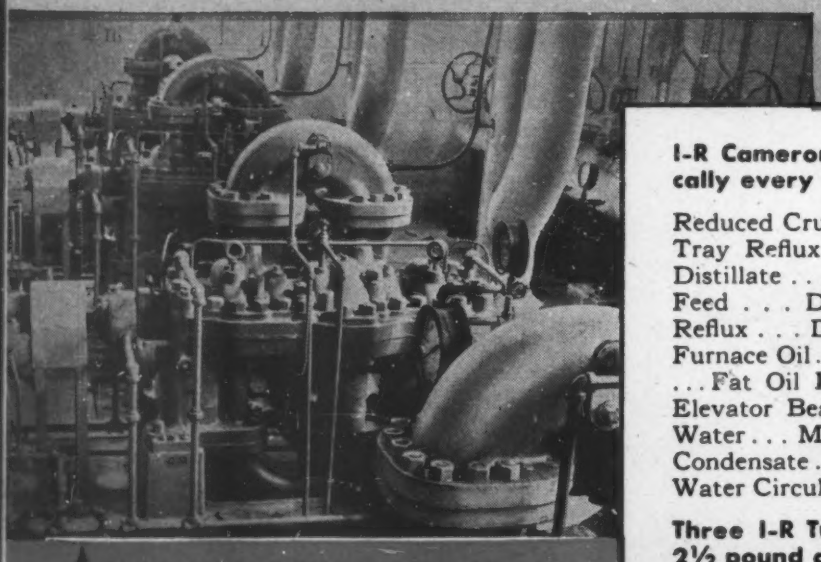
COPPUS ENGINEERING CORPORATION
622 Park Ave., Worcester, Mass.
Sales Offices in THOMAS' REGISTER
Other "Blue Ribbon" Products in REFINERY CATALOG.



Seven 600 BHP, two-stage, Type KVG Gas Engine Driven Gas Compressors.

COMPRESSORS, TURBO-BLOWERS AND CENTRIFUGAL PUMPS

SERVE RICHFIELD'S NEW AVIATION GASOLINE

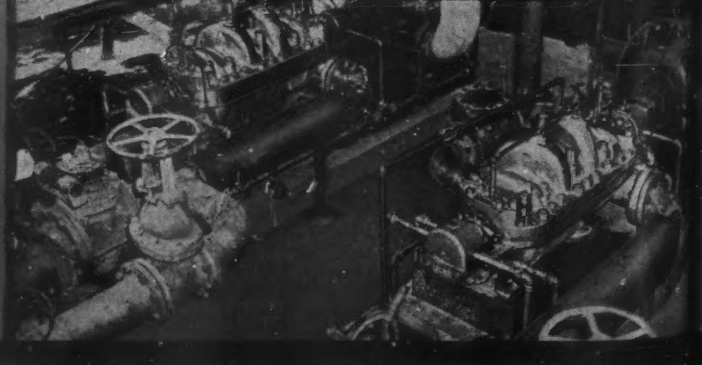


Richfield's new steam plant produces enough power for a city the size of Spokane. Here are 4 six-stage, 455 HP, Ingersoll-Rand boiler-feed pumps.

I-R Cameron Centrifugal Pumps are on practically every fluid stream in this new plant . . .

Reduced Crude Charge . . . Gas Oil Charge . . . Top Tray Reflux . . . Cracked Distillate . . . Treated Distillate . . . Recycle Naphtha . . . Depropanizer Feed . . . Debutanizer Feed . . . Depropanizer Reflux . . . Debutanizer Reflux . . . Lean Oil . . . Furnace Oil . . . Fuel Oil . . . Heavy Gasoline Charge . . . Fat Oil Intercondenser . . . Stripper Reflux . . . Elevator Bearing Water . . . Compressor Jacket Water . . . Main Water Supply . . . Back Wash . . . Condensate . . . Desuperheater . . . Booster . . . Kiln Water Circulating . . . Boiler Feed.

Three I-R Turbo-Blowers furnish 96000 cfm, 2½ pound air for the Catalytic Process.



Two I-R Cameron six-stage, heavy gasoline charge pumps each operating against a total head of 750 feet.

CALL IN THE FLUOR 'SPECIALIST' NOW!

This summer's operating records show what your water cooling requirements were during warm weather peaks. To be sure you maintain the efficiency of your Cooling Towers to meet next summer's demands, let Fluor make this vital Maintenance Check-Up during the colder months ahead while demands on your towers are lessened:

- Inspect decks and filling for sagging, accumulation of foreign matter, loss of parts, etc.
- Inspect distributing system for scale, rust, clogging, leaks, loss of pressure, etc.
- Determine quality and quantity of water flow. Look for rapid corrosion of metal parts and delignification in the wood.
- Check flow of effluent air for recycling troubles in mechanical draft towers.
- Inspect ladders, handrails, stairs and walkways for signs of weakening.
- Inspect structural members including bolts and castings for cracks, breaks and other causes of failure.
- Check motors, pumps, gears, fans, couplings and other mechanical equipment.

FLUOR Maintenance and Repair Service covers ALL MAKES and TYPES of Cooling Towers. As manufacturers of Fluor Aerator and Fluor Induced Draft Cooling Towers, Fluor M & R Service is complete and economical.

FLUOR

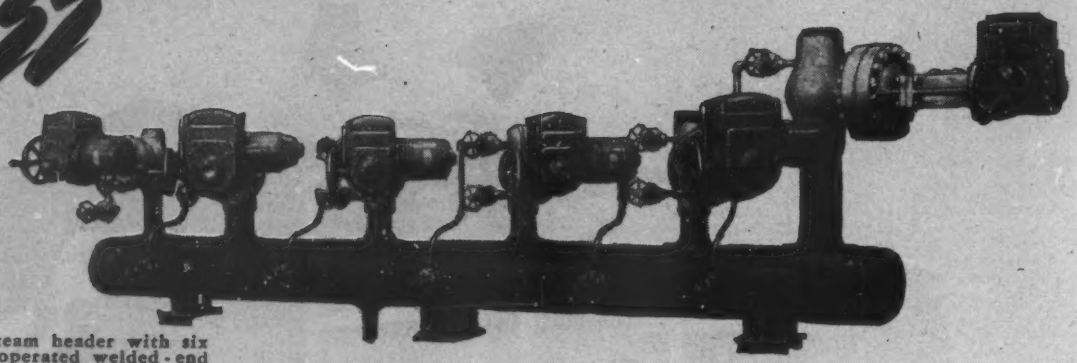
SINCE 1890

ENGINEERS • MANUFACTURERS • CONSTRUCTORS

PROCESS PLANTS AND EQUIPMENT FOR THE OIL, GAS AND ALLIED INDUSTRIES

THE FLUOR CORPORATION, LTD., 2500 S. ATLANTIC BLVD., LOS ANGELES 22 • New York, Pittsburgh, Kansas City, Houston, Tulsa

Puzzle FOR PIPING EXPERTS



Main steam header with six motor-operated welded-end valves – one of the many types of assemblies that require Grinnell's complete Pipe Fabrication facilities and "know-how".

With piping assemblies for modern industry becoming more and more complex, many specifications look like puzzles specially prepared for piping experts.

But Grinnell Pipe Fabricating specialists have never been stumped by "puzzles" like this – for good reason. They have all the *specialized* shop equipment necessary, in three modern pipe fabrication plants, to meet any requirements for fabricating piping for high pressure, high temperature service and for the most intricate assembly — — work that could not possibly be done in the field.

Make use of Grinnell's complete engineering and pipe fabrication facilities whenever plans call for a shop-fabricated job.

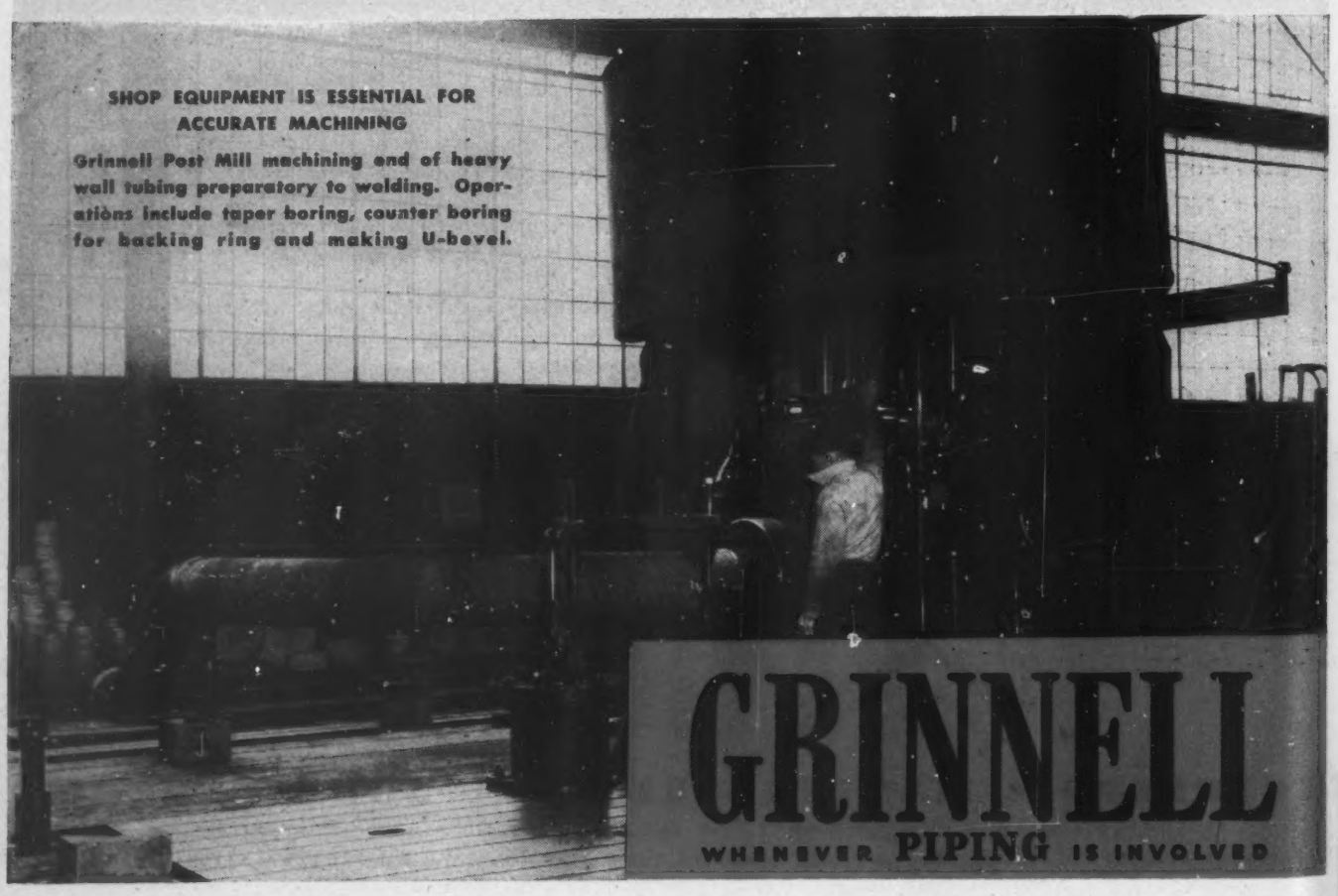
GRINNELL COMPANY, INC.
Executive Offices, Providence 1, R. I.

Pipe Fabrication Plants:

Providence, R. I. Atlanta, Ga. Warren, Ohio

Branches and Warehouses:

Atlanta 2, Ga.	Los Angeles 13, Cal.	Providence 1, R. I.
Charlotte 1, N. C.	Minneapolis 15, Minn.	St. Louis 10, Mo.
Chicago 9, Ill.	New York 17, N. Y.	St. Paul 2, Minn.
Cleveland 14, O.	Oakland 7, Cal.	San Francisco 7, Cal.
Houston 1, Tex.	Philadelphia 34, Pa.	Seattle 1, Wash.



SHOP EQUIPMENT IS ESSENTIAL FOR ACCURATE MACHINING

Grinnell Post Mill machining end of heavy wall tubing preparatory to welding. Operations include taper boring, counter boring for backing ring and making U-bevel.

GRINNELL

WHENEVER **PIPING** IS INVOLVED

Scovill Tube News

Vol. 2 SCOVILL MANUFACTURING COMPANY, Waterbury 91, Conn No. 4

Corrosion of Condenser Tubes ...Causes and Cures

Scovill offers two folders on obtaining longer tube life

Among the common causes of corrosion in condenser and heat exchanger tube metal are the following, each of which is discussed in two folders which have been prepared by Scovill Manufacturing Company engineers as one of three Scovill services to power plant operators:

Film Formation

The ability of copper and its alloys to form protective films on their surfaces explains their inherently excellent corrosion resistant properties. In order to be protective, the film must be adherent, continuous and relatively insoluble. The formation of soluble salts at the metal surface will lead to continued corrosion. Likewise, coatings which are porous, loosely adherent, friable or easily broken, or discontinuous, offer little protection to the metal.

Accelerated Uniform Corrosion

Tubes in service under conditions which result in corrosion at the tube surface with the formation of soluble salts only, will undergo a uniform thinning of the tube wall. This is often experienced in acid solutions, particularly with oxidizing acids or acid solutions containing oxygen or an oxidizing agent. Solutions which have a definite solvent action on the products of corrosion of copper alloys, such as solutions containing ammonium hydroxide or cyanides, would behave similarly.

Impingement Attack, End Corrosion, etc.

Rapid and repeated destruction of protective surface films usually occurs at or near the inlet end of the tubes and is variously described as "impingement attack, end corrosion, etc." There are usually certain localized areas in a unit or sections of a unit where failures from this cause predominate. The destruction of protective films at such localized areas is due to a relatively high velocity of the circulating medium, together with a turbulent condition and the action of entrained or separated air.

Concentration Cell Action

Many cases of localized corrosion and failure of condenser and heat exchanger tubes are due to local differences in solution concentration or composition which may develop at the metal surface. A break in an otherwise satisfactory protective film may initiate such action. Cracks, crevices or other small openings at baffle or support plates where liquids may seep and become trapped are always a potential source of trouble in this respect.

Deposit Attack

Corrosion of the "deposit attack" type (a special form of "concentration cell" action) is directly due to the settling out or lodgment on the tube wall of sand, mud, coke, stones, wood, shells, flakes of iron scale, etc. Part of the metal surface becomes shielded or protected by the deposit and usually becomes anodic to adjacent metal areas; intense pitting at such shielded areas is likely to occur. If the deposit is of sufficient size to interfere seriously with the flow of the circulating medium, turbulence, air separation and erosion-corrosion of the down-stream side of the tube may take place.

Plug- and Layer-Type Dezincification

Brasses containing less than 85% of copper may undergo corrosion which results finally in the gradual replacement of the brass by a spongy, porous copper deposit. This deposit may occur locally, developing into "plugs" of copper, or it may occur uniformly over the tube surface — in which case it is designated as "layer-type" dezincification. Conditions which favor dezincification of condenser tubes are:

(1) Contact with waters slightly acid in character and of a low degree of aeration.
(2) Relatively low velocity of water over the tube surfaces, or stagnant water in tubes.
(3) Relatively high temperatures.
(4) Certain types of permeable scales on the metal surface.

Galvanic Action

The indiscriminate use of dissimilar metals and alloys in any service, when they make good contact and are also subjected to a conducting medium, may lead to the early failure of one member of the couple. In the design of equipment which is to be used for handling liquids, moist gases or vapors, therefore, the possibility of galvanic corrosion should be given careful thought.

Such are the common causes of trouble. The cures for these troubles may be determined with the aid of Scovill's two other services:

Service in Men, which gives you the benefit, through consultation, of the many years' experience represented by Scovill engineers.

Service in Metals, which gives you complete laboratory and production facilities (as national needs permit) in the working-out of a solution to your problem.

For a further demonstration of *Service in Manuals*, of which the foregoing information is a sample, write us for Scovill's free "Condenser Tube Booklet", containing diagrams, formulae, description of alloys. Address Scovill Manufacturing Company, 15 Mill St., Waterbury, Conn.

THIS IS NUMBER TEN in a Series of Scovill Advertisements to help you get longer life from condenser and heat exchanger tubes.

Scovill
MANUFACTURING COMPANY
WATERBURY, CONN.

SCOVILL CONDENSER TUBES

ONE PRODUCT... THREE SERVICES

Service in Manuals... Service in Metals... Service in Men

REMOTE CONTROL
of TEMPERATURE, PRESSURE and FLOW

The news comes by air when Bristol's Metavane System is employed for telemetering measurement of vital variables in the manufacture of high octane gasoline, butylenes for synthetic rubber and other products.

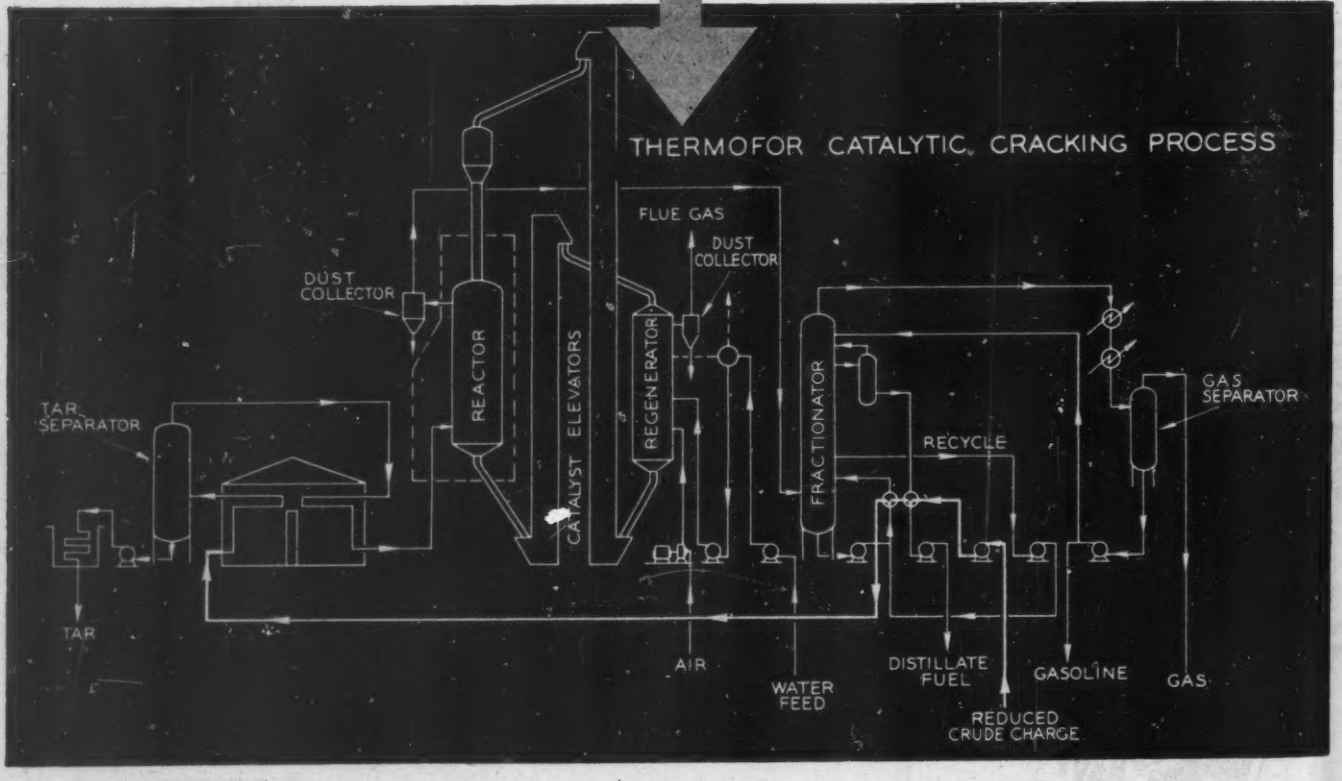
Illustrated is one of the newest refinery processes in the production of aviation fuel and butylenes for synthetic rubber. The Reactor Unit forms a critical part of this process. Bristol instruments of standard design help to provide high operating efficiency and product yield by maintaining precise values of temperature, pressure and flow. Recording and control instruments are centrally located at distances of up to several hundred feet from the points of measurement.

BRISTOL'S METAVANE SYSTEM

Information gathered by the Metavane Transmitter is passed on rapidly over a length of tubing to a Metavane Receiver at the control point. A 15 lb. air supply introduced at the Transmitter powers the system.

The Receiver may be a standard Recorder or an automatic Free-Vane Controller of either the Monoset, Ampliset, Preset, Reset or Magniset type, which actuates the proper mechanism, by air, to bring values into line.

Bulletin M1701 will give you complete information on the instruments used in this application.

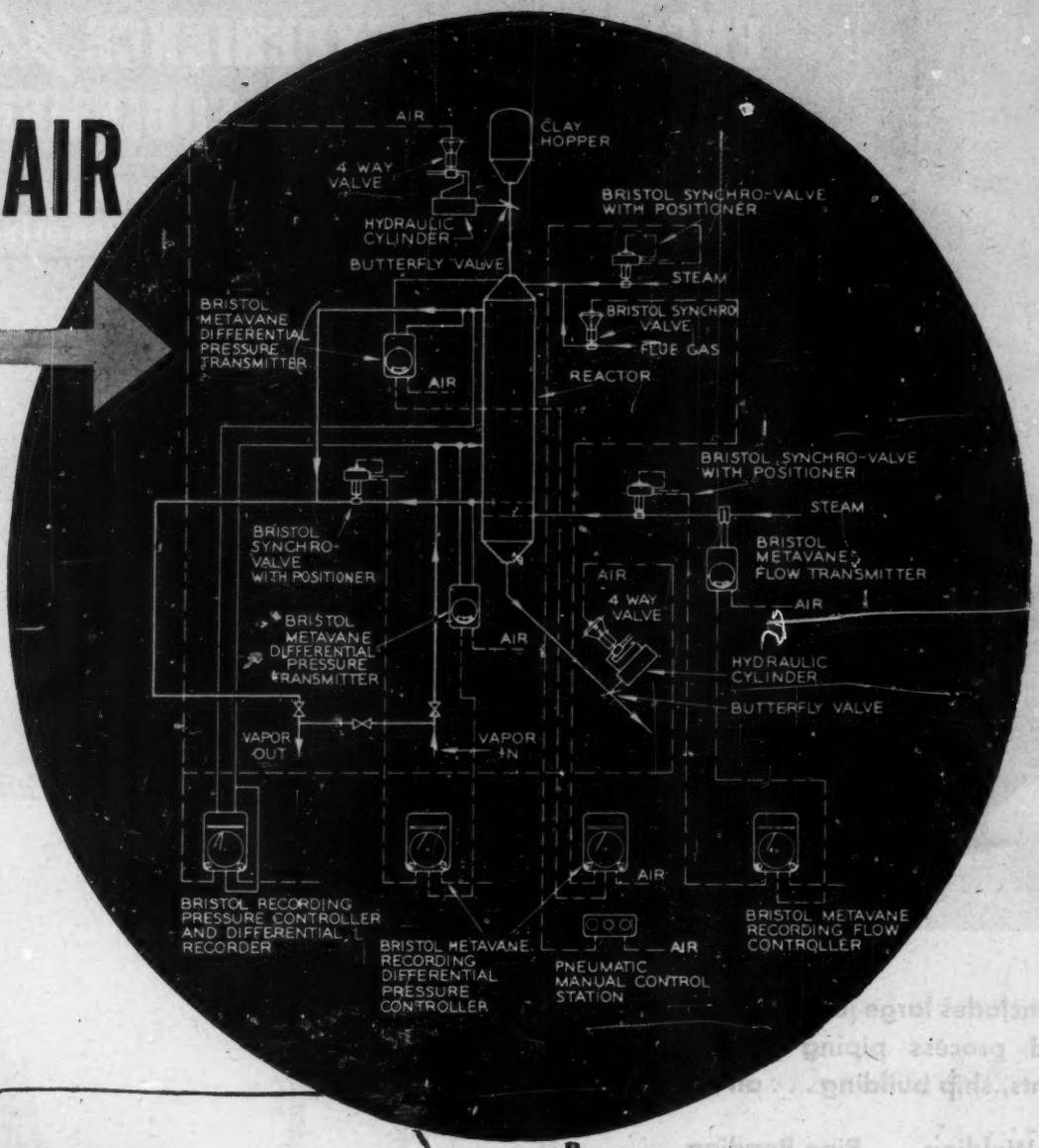


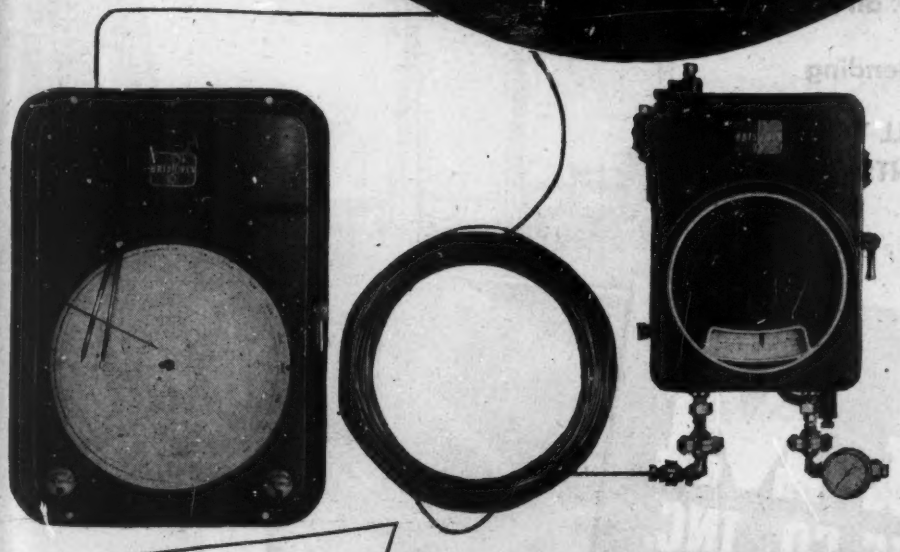
THE BRISTOL COMPANY
111 Bristol Road, WATERBURY 91, CONNECTICUT

The Bristol Company of Canada, Ltd.
Toronto, Ontario

Bristol's Instrument Co., Ltd.
London N.W. 10, England

VIA AIR





METAVANE FLOW CONTROLLER

Equipment illustrated is used for controlling flow

BRISTOL

. . . Bristol's Extra Refinements Give Better Refinery Control

AUTOMATIC CONTROLLING AND RECORDING INSTRUMENTS

ENGINEERING EXPERIENCE *plus* COMPLETE MODERN EQUIPMENT

assures designing, fabricating and welding done right and at the time promised.

EXPERIENCE includes large jobs fabricating high pressure and process piping for refineries, chemical plants, ship building . . . all industries.

Code Welding . . . Pipe Bending

CONSULT WITH US ON ALL YOUR PIPING REQUIREMENTS

M B & M

PIPE FABRICATING CO., INC.

OFFICES
731-732 BANKERS MORTGAGE BLDG.,
HOUSTON 2, TEXAS

PLANT
1705 RUIZ STREET
HOUSTON 2, TEXAS

Call THE CORBETT CORPORATION *for*

GLOBE STEEL TUBES for seamless steel boiler and condenser tubes.

Among the well known lines available to you through The CORBETT CORPORATION are:—

TAYLOR forged Steel Flanges and Fittings • JENKINS Valves • YOUNGSTOWN Pipe • ROCKWOOD Unions • WATSON-STILLMAN Forged Steel Fittings • GLOBE Boiler and Condenser Tubes • LAMSON & SESSIONS Rivets and Bolts • WORTH Steel Heads and Plates.

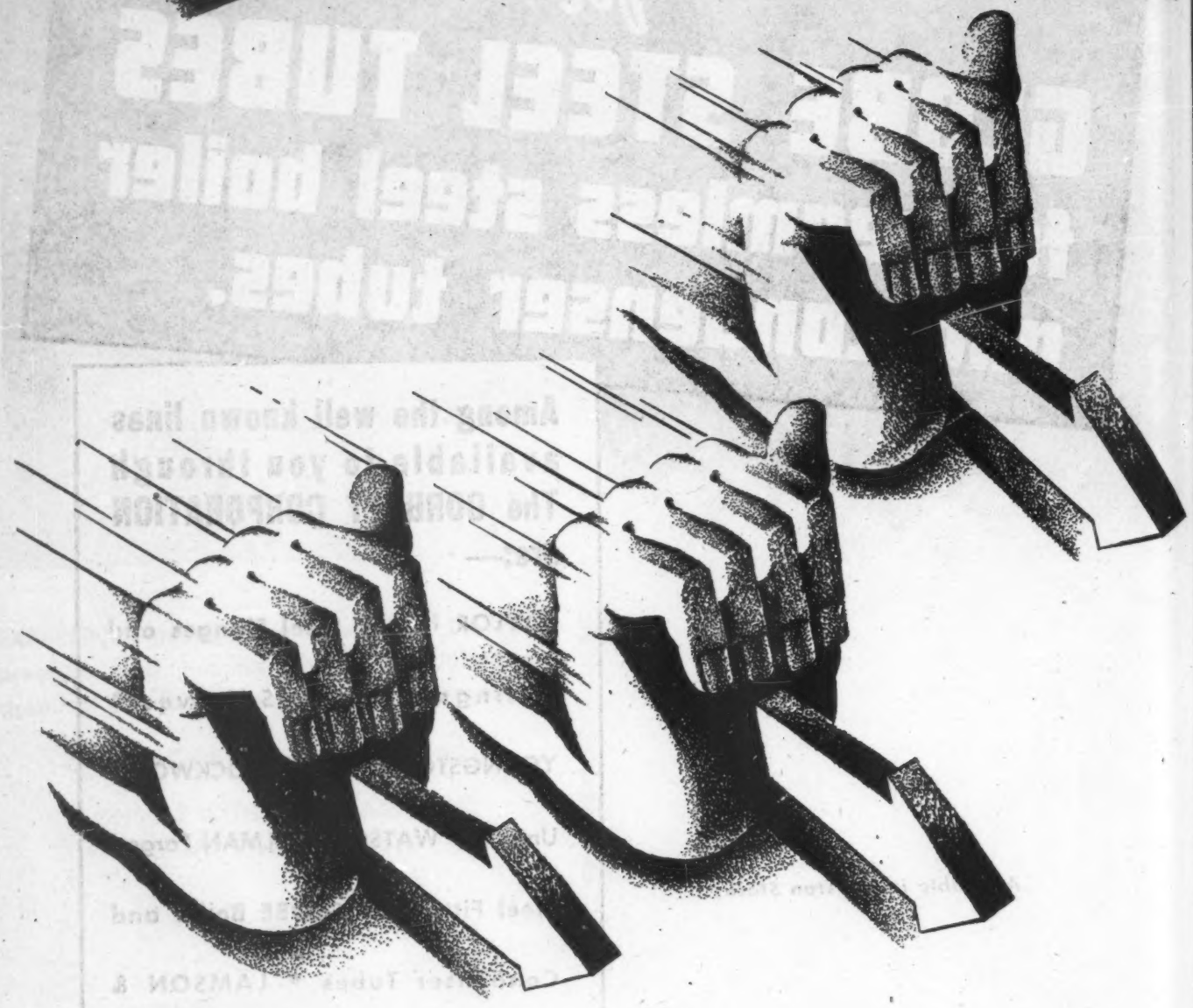
Available in Houston Stocks

The CORBETT *Corporation*

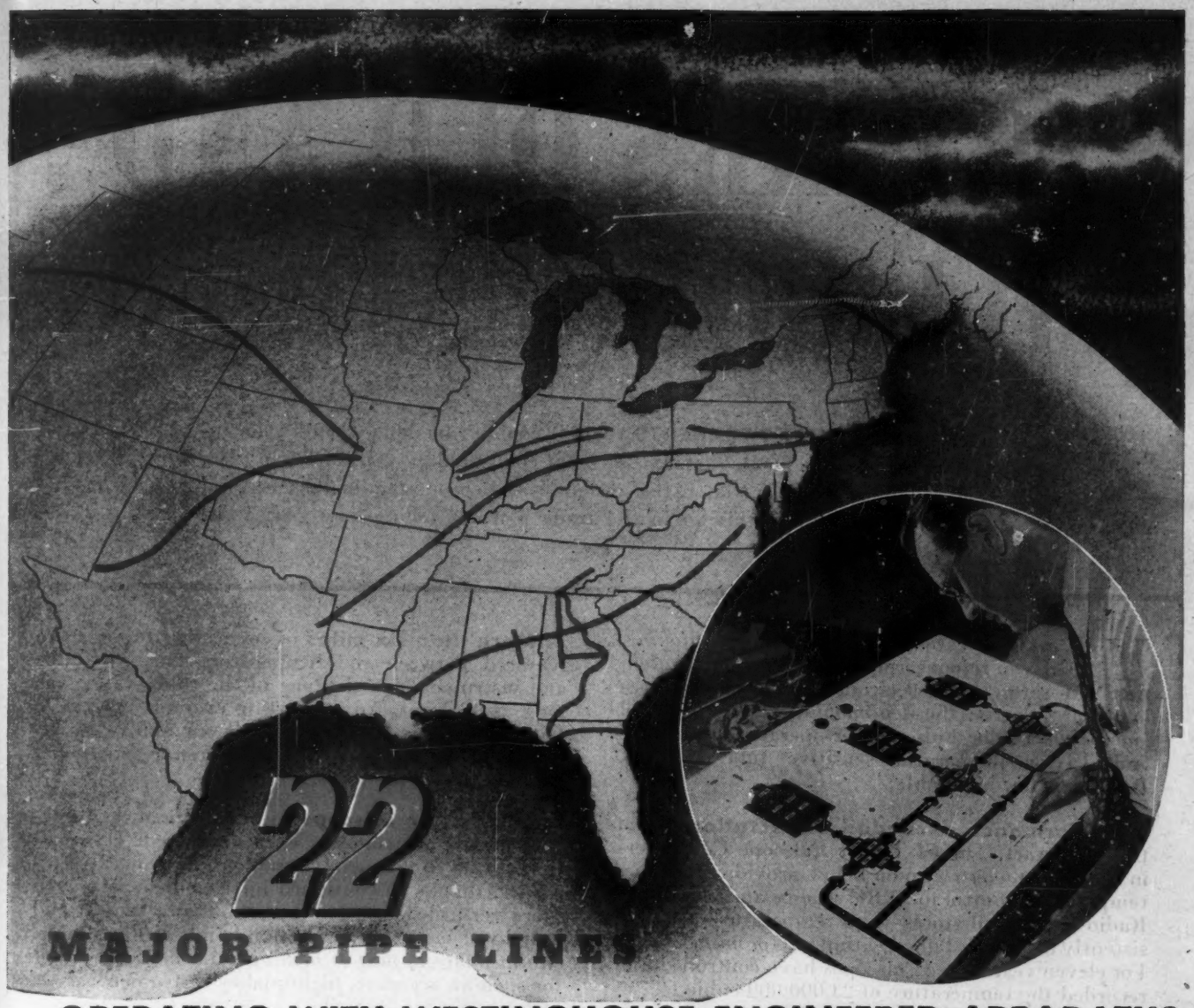
CAPITOL 5325

2431 SUMMER ST. P. O. BOX 42 HOUSTON 1, TEXAS

THREE NEW PARTNERS ... GOING



TERMINAL TOWER
CLEVELAND, OHIO



...OPERATING WITH WESTINGHOUSE ENGINEERED APPARATUS

HERE'S THE HONOR ROLL

"Big Inch"
"Little Big Inch"
Magnolia—Midland-Corsicana
Stanolind—Wyoming
Bayou
Plantation
Trans-Florida
Great Lakes
Project 5—Eldorado-Helena
Portland-Montreal
Southeastern
Shell, Calif.
Standard of Ohio—Lima-Toledo
Stanolind—W. Texas-Oklahoma
Pan American
Sinclair
Continental—Corpus Christi
Continental—Wyoming
Tuscarora
Phillips—E. St. Louis-Chicago
Socony-Vacuum—E. St. Louis-Ohio
Shell—Eastern

Westinghouse experience makes available specialized equipment above and beyond the call of ordinary requirements.

For example, in the "Little Big Inch" recently completed, Westinghouse developed and supplied to all 29 stations a special control desk which shows the status of all operations through the station at all times. This is an invaluable aid to fast and efficient dispatching of today's war loads.

The *specialized* Westinghouse experience in every phase of the petroleum industry is yours to help solve any petroleum handling or pipe line problem. Call your nearest Westinghouse office. Westinghouse Electric & Manufacturing Co., Box 868, Pittsburgh 30, Pa. J-94623

Westinghouse

PLANTS IN 25 CITIES . . . OFFICES EVERYWHERE

Electrical Equipment for the Petroleum Industry

11 YEARS OLD AND STILL GOING STRONG!

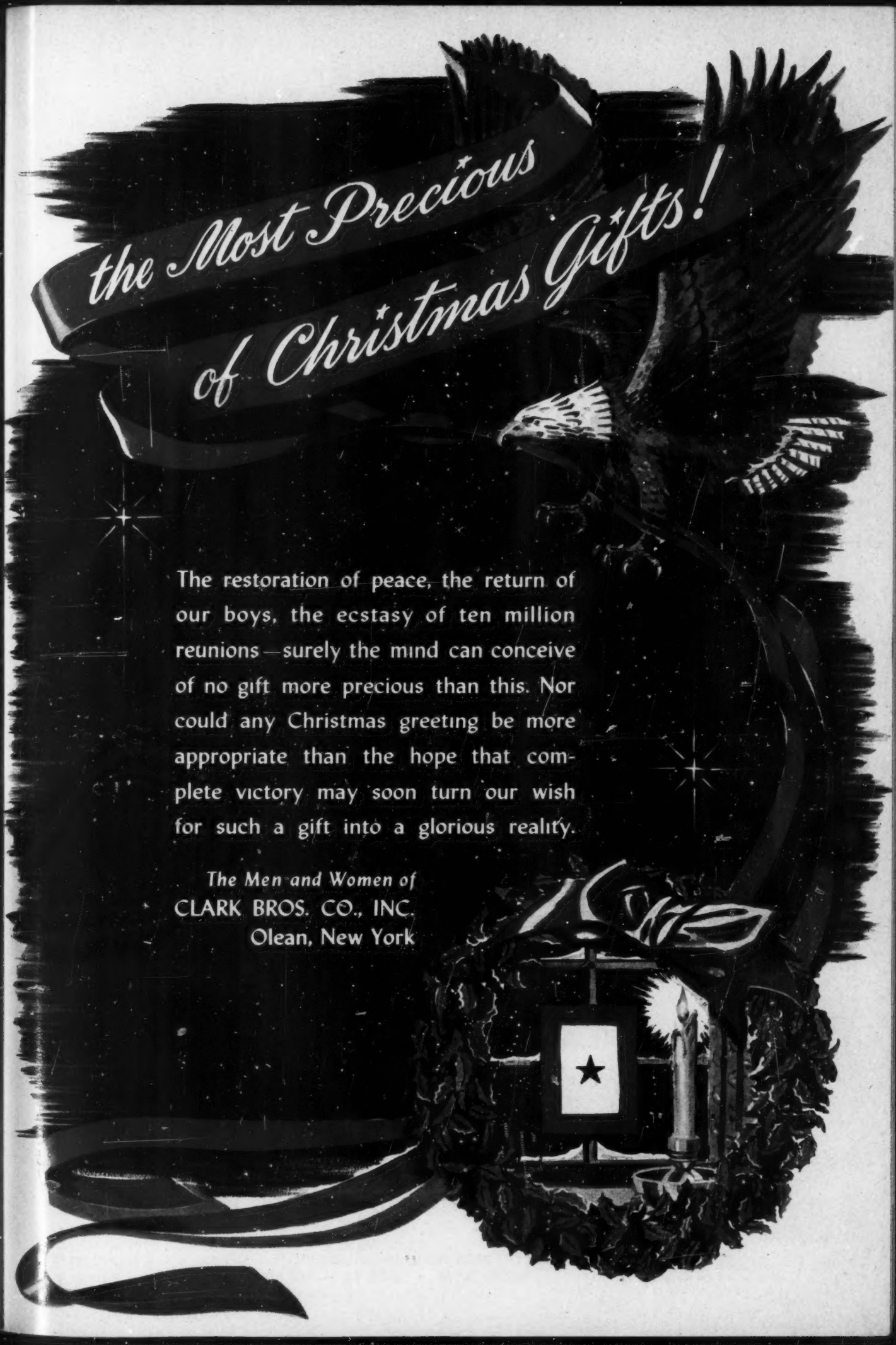
SOME INSTRUMENT "EXPERTS" said it couldn't be done when Taylor installed the controls for Radio City's huge air conditioning system back in 1933. Yet today, eleven years later, the system is still so outstandingly successful that NBC is running this ad in the trade journals telling how good it is!

YOU may not care a hoot about *air conditioning.* But if you're concerned about *instrumentation*, this NBC setup should set your mind at rest on three important points: the *dependability*, *versatility*, and *low cost* of Taylor Fulscope air-operated controllers and Taylor temperature-sensitive tube systems. Here are a few highlights:

1. Performance exceeded expectations from the very start. The 64 Taylor Fulscope Controllers in the central control room below provide *individual* temperature control for NBC studios and offices and Radio City retail stores—and temperature has consistently been maintained within *plus or minus* ½° *F.* For eleven years these Fulscopes have controlled and recorded the temperature of 23,000,000 cubic feet of air per hour, providing a complete change of air *every 8 minutes.*

2. More than six miles of connecting tubing were required between the temperature-sensitive bulbs and instruments, with some of the tube systems as long as 425 feet. An interesting example of NBC's faith in this kind of system and our ability to engineer it, is that they *cemented the connecting tubing permanently in the walls.*

3. The Taylor Fulscope is one of the most versatile, flexible instruments ever developed. It would have to be to do such a complex job. Today's Fulscopes, thanks to continued improvement, are even more versatile. Yet they are essentially rugged and long-lived because their action is inherently simple. *Maintenance is next to nothing.* And *first cost is low* for such an accurate, high quality instrument.


the Most Precious
of Christmas Gifts!
The restoration of peace, the return of our boys, the ecstasy of ten million reunions—surely the mind can conceive of no gift more precious than this. Nor could any Christmas greeting be more appropriate than the hope that complete victory may soon turn our wish for such a gift into a glorious reality.
The Men and Women of
CLARK BROS. CO., INC.
Olean, New York

VIBRATION CAUSING A "SHAKE-DOWN"?

SIMPLY APPLY UNIBESTOS

it's simple to apply!

Here's an insulation that can take hard knocks without denting or shattering—can withstand severe vibration without either sagging or gapping. Unibestos' resilient, tough fibrous construction affords outstanding structural strength.

Unibestos is available in half-section form up to 30" pipe diameter and in quarter-section form from 32" to 60", in thicknesses from ¾" to 5" . . . Single layer construction is available for service up to 1200°.

UNION ASBESTOS
MEANS PROGRESS IN INSULATION
AND RUBBER CO.

COPYRIGHT 1941
UNION ASBESTOS AND RUBBER CO.

PLANTS: 1821 S. 54th Ave., CICERO, ILL. • PATERSON, N. J. • BLUE ISLAND, ILL.
OFFICES: CHICAGO • CICERO, ILL. • NEW YORK • SAN FRANCISCO • PATERSON, N. J.

VERSATILE AVAILABLE

CHLOROSULFONIC ACID

for use in certain reactions . . .

CHLOROSULFONIC ACID ($HOSO_2Cl$) is a versatile heavy chemical offering broad possibilities in many types of chemical reactions. It finds use in the manufacture of both intermediates and finished products. The use of Chlorosulfonic acid often results in better yields—reduced costs—improved quality. The above processes illustrate some of the applications for this interesting reaction tool.

For further information, write: E. I. du Pont de Nemours & Co., (Inc.), Grasselli Chemicals Department, Wilmington 98, Delaware.

TYPICAL ANALYSIS OF DU PONT CHLOROSULFONIC ACID

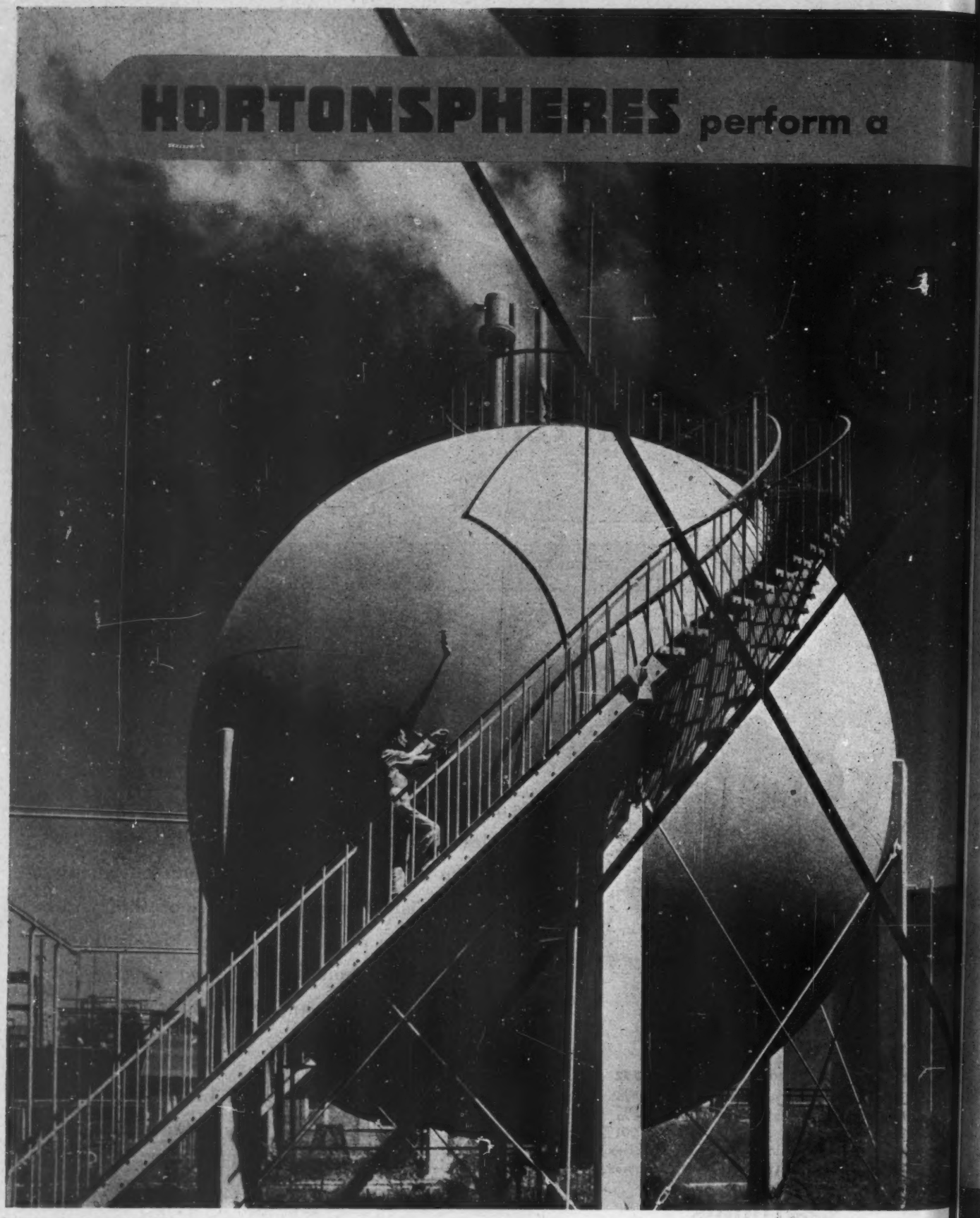
Specific gravity @ 60°F.	1.752
Total Chlorosulfonic acid ($HOSO_2Cl$)	98.8%
Free Sulfuric acid (H_2SO_4)	0.7%
Iron (Fe)	0.001%
Boiling point	316°F. (Approx.)
Freezing point	—112°F. (Approx.)

DU PONT

BETTER THINGS FOR BETTER LIVING
. . . THROUGH CHEMISTRY

DU PONT CHLOROSULFONIC ACID

Now used in tank car quantities by many manufacturers



CHICAGO BRIDGE

BIRMINGHAM • CHICAGO • CLEVELAND
HAVANA • HOUSTON

REPEAT ORDERS

PETRO-CHEM'S
RECORD OF ISO-FLOW* FURNACE INSTALLATIONS FOR SEVEN LEADING OIL REFINING COMPANIES.

Over 175 units are now in operation or under construction for virtually every type of service in the Petroleum Refining and Chemical industries.

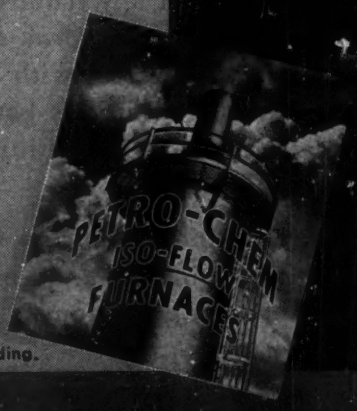
	Initial Order	Second Order	Third Order	Fourth Order	Fifth Order	Sixth Order	
Company A	1	6	3	2	1	1	6 Orders
Company B	1	8	16	16	3		5 Orders
Company C	1	1	1	1	1		5 Orders
Company D	1	1	1	6	1		5 Orders
Company E	1	1	1	16			4 Orders
Company F	1	1	2	1			4 Orders
Company G	1	2	1				3 Orders

PETRO-CHEM

ISO-FLOW* FURNACES ARE

UNLIMITED

IN SIZE, CAPACITY AND DUTY.



*Reg. U.S. Pat. Off. Patents issued and pending.

PETRO-CHEM DEVELOPMENT CO., INC.
120 EAST 41st STREET, NEW YORK 17, N. Y.
Representatives: Faville-Levally Corp., Chicago
Bethlehem Supply Co., Tulsa, Houston, Los Angeles

14-Valve . . .
. . . WELDED MANIFOLD for FUEL OIL TRANSFER

Shown above is a 2-inch valve welded manifold for transfer of fuel oil between storage tanks. Designed for a working pressure of 150 lbs. and tested to 500 lbs. this unit provides a compactness and freedom from maintenance common to all *"Code-Craft"* manifolds.

There is practically no limit to the combinations of valve arrangements possible in *"Code-Craft"* welded construction. Any number of valves of any type and in any size, in single and double manifolds, of carbon and stainless steel, chrome iron, nickel, Monel and other alloys, can be combined in an integrated unit to meet any requirements in liquid, steam or vapor service. Advantages of *"Code-Craft"* Welded Valve Manifolds include: greater strength with less weight; elimination of bolts, gaskets and flanged fittings between valves; substantial savings in insulation costs; elimination of patterns and leaky castings; minimum pressure drop.

We welcome inquiries from engineers in the Petroleum and Petro-chemical industries. Send us your drawings or specifications for prompt quotations.

OTHER *"Code-Craft"* PRODUCTS INCLUDE . . .

- Expansion Joints
- Heat Exchangers
- Fuel Oil Heaters
- Single and Twin Oil Strainers for pressure and suction service
- Flexible Connectors

"Code-Craft" . . .

ZALLEA BROTHERS & JOHNSON

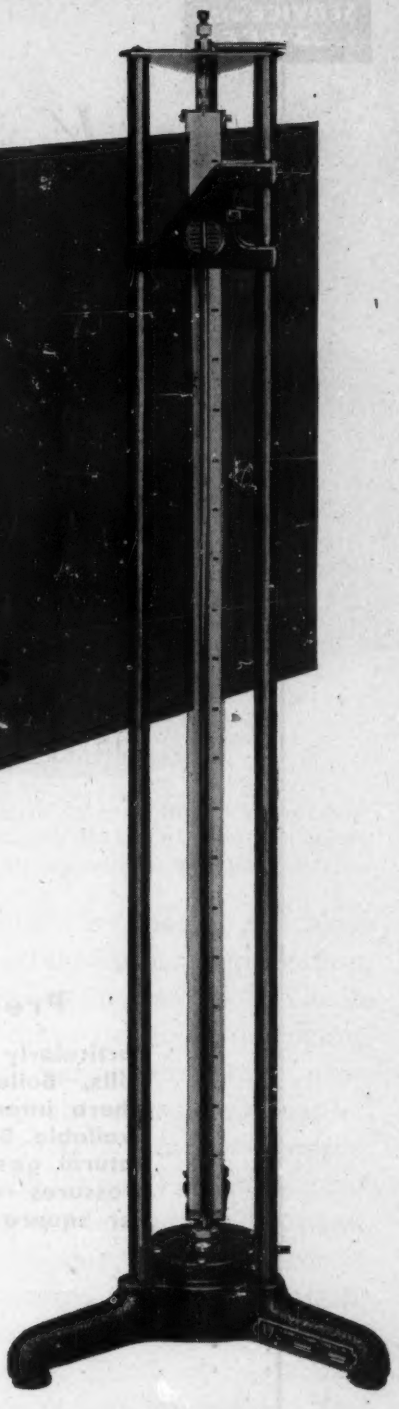
. . . EQUIPMENT FOR THE PROCESS INDUSTRIES

890 LOCUST ST. • WILMINGTON 99 • DEL.

WHEN MINUTES COUNT

W&T MERCURIAL MANOMETERS

Give
more rapid readings
Greater accuracy



more rapid — because temperature corrections are made in advance by simply setting the temperature correction dial.

more accurate — because a knife-edge float — rather than a meniscus — is read directly, through a magnifying eyepiece, assuring accuracy to 0.004 of an inch of mercury.

This instrument is described and illustrated in Technical Publication 248

WALLACE & TIERNAN
PRODUCTS, INC.

A-34

BELLEVILLE 9 **NEW JERSEY**

THE WEBSTER ENGINEERING CO.

QUALITY EFFICIENCY SERVICE with SPEED

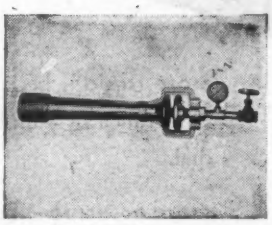
Knowledge of combustion problems as applied to petroleum processing, plus the type of burner and control equipment used, enables us to supply the combustion units for any refinery installation. Webster Engineered Burner Installations are a guarantee of performance "as specified."

•

WEBSTER SERIES VI

Premixing Gas Burner

Particularly adaptable to use in Cracking Units, Stills, Boilers, and any other applications where intermediate or high pressure gas is available. Burns any character or B. T. U. value natural gas, mixed gas, or artificial gas at pressures ranging from one to thirty pounds per square inch.



Consult* WEBSTER *First!

THE WEBSTER ENGINEERING COMPANY

TULSA, OKLAHOMA

F. J. EVANS ENGINEERING CO.
Houston, Texas

REPRESENTATIVES:
NATURAL GAS EQUIPMENT CO.
Los Angeles and San Francisco
And ALL Surface Combustion Offices

OIL FIELD EQUIPMENT CO.
New York City

Not all synthetic gloves are oil resistant!

Stanzoils—
more hand safety for your money

Fewer pairs needed in a year when you protect employees' hands from oils, acids, caustics with Stanzoils of DuPont's neoprene — they give better protection 3 to 7 times longer than rubber . . . keep busy hands safe, prevent costly injuries and lost time. Workers like them — Stanzoils are the choice of hundreds of industries. Weights, sizes, lengths for all needs, black or white — *including new lightweight RSW-13 with remarkable non-slip fingers.* Write today for the whole story.

STANZOIL PIONEER

Synthetic Rubber Division
THE PIONEER RUBBER COMPANY
270 Tiffin Rd., Willard, Ohio, U.S.A.
New York • Los Angeles

MADE WITH DU PONT NEOPRENE

WALDRON Gear Type COUPLING

1 Exclusive WALFLEX Seal keeps CLEAN oil in and dust out.

2 Forged Steel hubs and sleeves —no welding—no distortion of internal gears.

3 No non-lubricated metal against metal on moving parts to cause wear.

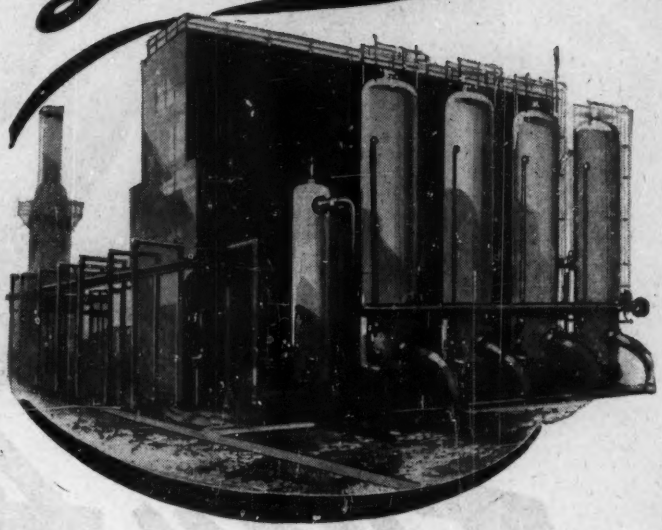
4 Minimum stress on shaft and bearings due to freedom of movement between hub and sleeves.

Catalog with rating tables sent on request

JOHN WALDRON CORP.
Main Office and Works
New Brunswick, New Jersey
COUPLINGS

IN THIS EFFICIENT DRYER THE DESICCANT IS

Florite*



Natural gas is dehydrated by the use of Florite in this modern plant of an important company operating in the Southwest.

Made from bauxite by special processes of activation and mechanical adaptation, regenerated by heating to 350°F., Florite is superior to other granular desiccants for many and varied industrial uses. Dehydration of natural gas, represented by the illustration above, is one example. Hydrofluoric alkylation of aviation gasoline is a quite special example. Propane, butane, air, nitrogen, carbon dioxide, refrigeration compounds, and various other fluids are successfully and economically treated. Some of these uses have been established for years. New ones are developed from time to time. Correspondence is invited.

*Trade Mark Registered.

FLORIDIN COMPANY, INC.
ADSORBENTS

Room 55, 220 Liberty Street — Warren, Pa.

Fifty Acres

READY FOR ACTION!

In a *single pound* of Synthetic "Fluid" Cracking Catalyst there is a surface area of approximately *50 acres!* Because of this vast chemical surface, the entire Catalytic Cracking process has been made faster and more efficient with resulting greater yields of higher quality gasoline.

Today, literally *millions of acres* of this Catalyst are being turned out by Cyanamid.

Shipping distances and shipping times to a majority of Aviation Gasoline refineries are less from Fort Worth where Cyanamid produces Synthetic Cracking Catalyst than from any other producing point.

Cyanamid technical men will be glad to furnish authorized companies with information regarding Synthetic Cracking Catalyst, its characteristics and its availability.

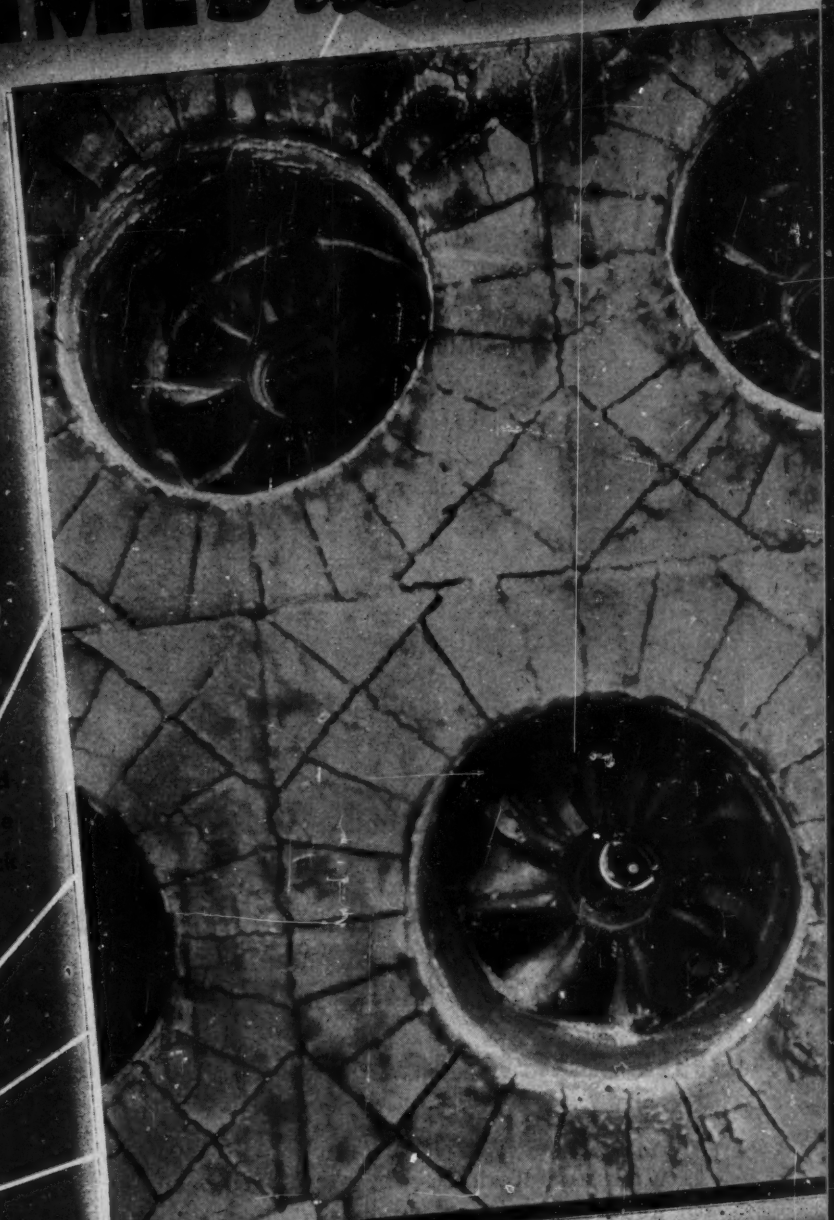
U.O.P. SYNTHETIC *Fluid* CRACKING CATALYST

AMERICAN CYANAMID
& CHEMICAL CORPORATION
(A Unit of American Cyanamid Company)
30 ROCKEFELLER PLAZA · NEW YORK 20, N. Y.

When BURNER RINGS last 3 TIMES as long...

The service they went through was terrific—24 hours a day . . . 7 days a week . . . no let-up . . . plus capacity . . . full head of steam . . . no time for shut-down. They took the punishment . . . they delivered. When burner rings last 3 times as long under that kind of service, look to the engineering.

The unretouched photograph here shows a set of burner rings—Detrick Burner Rings that have been in use three times the normal span of life for burner rings. Performance like this is typical evidence of the soundness of Detrick engineering—practical engineering that knows materials and how to use each for its best function. In this case the principle of specialization and individuality supplying the right material for the long life of the ring and the Detrick Well and Arch that went with them.



Look to the Engineering

Detrick Walls and Arches in Post-War Operation

Now is the time to get your post-war plans on the boards. Let us look over your blueprints and make suggestions for improvements and modernization that can be made in the immediate future, providing greater capacity or higher efficiency from present equipment. Detrick Suspended Walls and Arches will continue to give plus service in peace time as they have in the past during the war, adding to the lives of furnaces, enclosures and saving money for their owners. Ask for our new catalog "Detrick Furnace Enclosures."

DETRICK COMPANY
111 West Washington Street, Chicago 2, Ill.

If it's a problem of enclosing heat, it's a job for Detrick

DETRICK FURNACE ENCLOSURES

USE DETRICK INSULATION . . . PLASTIC or BLOCK

You'll find 1000 uses for these packings

J-M Wick and Rope Packings are useful for emergencies—*anywhere*

IT'S GOOD SENSE to have some Johns-Manville Asbestos Wick and Rope Packings handy for emergencies or for general use anywhere. There's no end to the ways in which these packings can prove valuable to you.

With its own source of supply from the world's largest asbestos mine, J-M has complete control of the quality of J-M Packings and is able to supply a wide range of styles to meet all needs.

For complete details on these and other useful J-M Packings, write for the J-M Packings Catalog. Johns-Manville, 22 East 40th Street, New York 16, N.Y.

3 TYPES

J-M Asbestos Wick Packing—twisted asbestos material that's easily handled and highly heat-resistant. Useful anywhere, especially for packing small valve stems on exhaust lines, heating systems; for caulking cracks in retorts, ovens, and boiler walls.

J-M Twisted Asbestos Rope Packing (illustrated above) is larger in diameter but otherwise similar to J-M Asbestos Wick. Asbestos Rope conforms readily to irregularities and is easily worked and compressed. Use it for packing, caulking or gasketing wherever a thicker material than Asbestos Wick is required.

J-M Braided Asbestos Rope has a firmer, more compact structure. It thus stands up better to abrasion and to severe usage over long periods of time. Use it as groove packing or for insulation on flexible or curved heated piping—wherever the use requires a dry, heat-resistant packing which can take rough usage.

JM PRODUCT

Johns-Manville PACKINGS & GASKETS

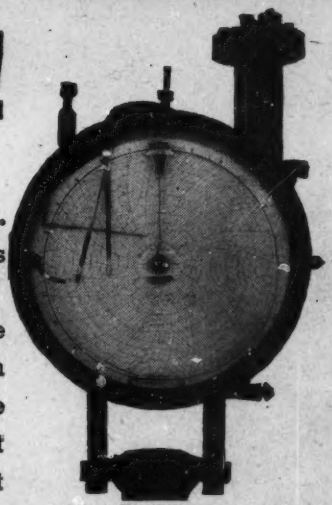
THERE'S A J-M DISTRIBUTOR NEAR YOU

All these EXTRA METER VALUES at NO EXTRA COST!

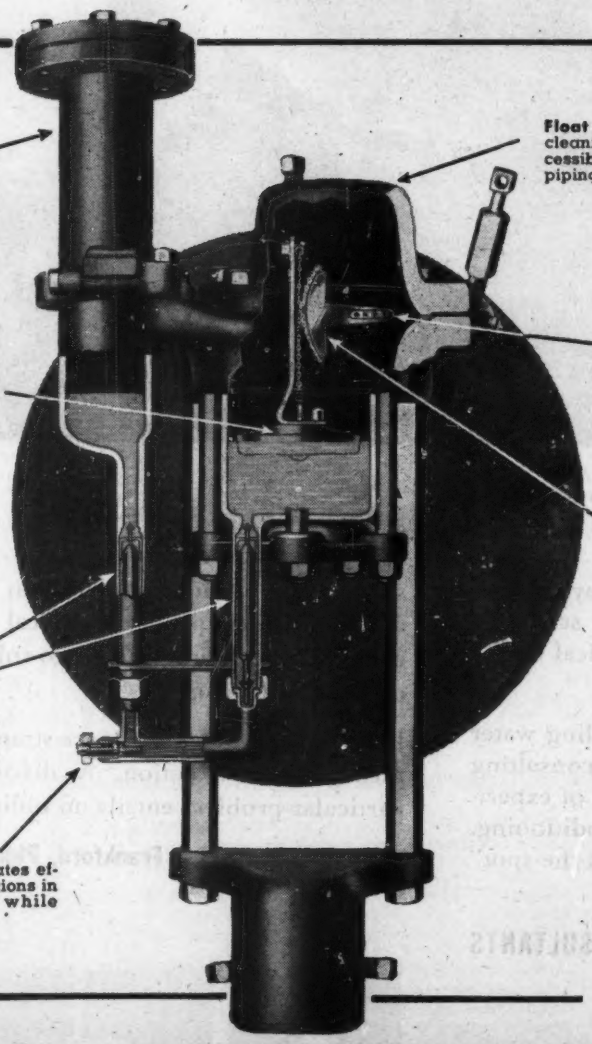
It's just plain "good business" to make sure you get full value from your meter investment. Over 45,000 installations of Foxboro Flow Meters have demonstrated that these meters give you "more for your money!"

Foxboro Flow Meters cost no more. Yet, their *engineered simplicity* provides important extra values . . . easier installation . . . simpler, less-frequent servicing . . . positive saving of mercury . . . unvarying accuracy throughout years of use.

Special Foxboro features that produce these extra values are "spotlighted" in the illustration. They are some of the major advances in meter design that Foxboro has introduced during the last 30 years of leadership in flow meter development and installation.



FOXBORO TYPE 7000 FLOW METER Available with integrator, automatic control mechanism, extra pens for temperature and pressure.



Interchangeable pressure chamber permits speedy alteration of range without disturbing meter calibration.

Float chamber designed for easy cleaning. Provides complete accessibility without disconnecting piping.

Extra-large float with long travel gives extra power . . . insures sustained accuracy with a minimum of maintenance.

Pressur-Tite Bearings for transmitting float motion to pen arm. No stuffing box . . . no packing . . . practically frictionless.

Segmental Lever . . . an exclusive Foxboro design . . . gives Straight-Line motion from float to pen-point . . . eliminates angularity errors and lost motion.

Sure-Seal Check Valves positively prevent mercury losses, even in cases of severe over-range.

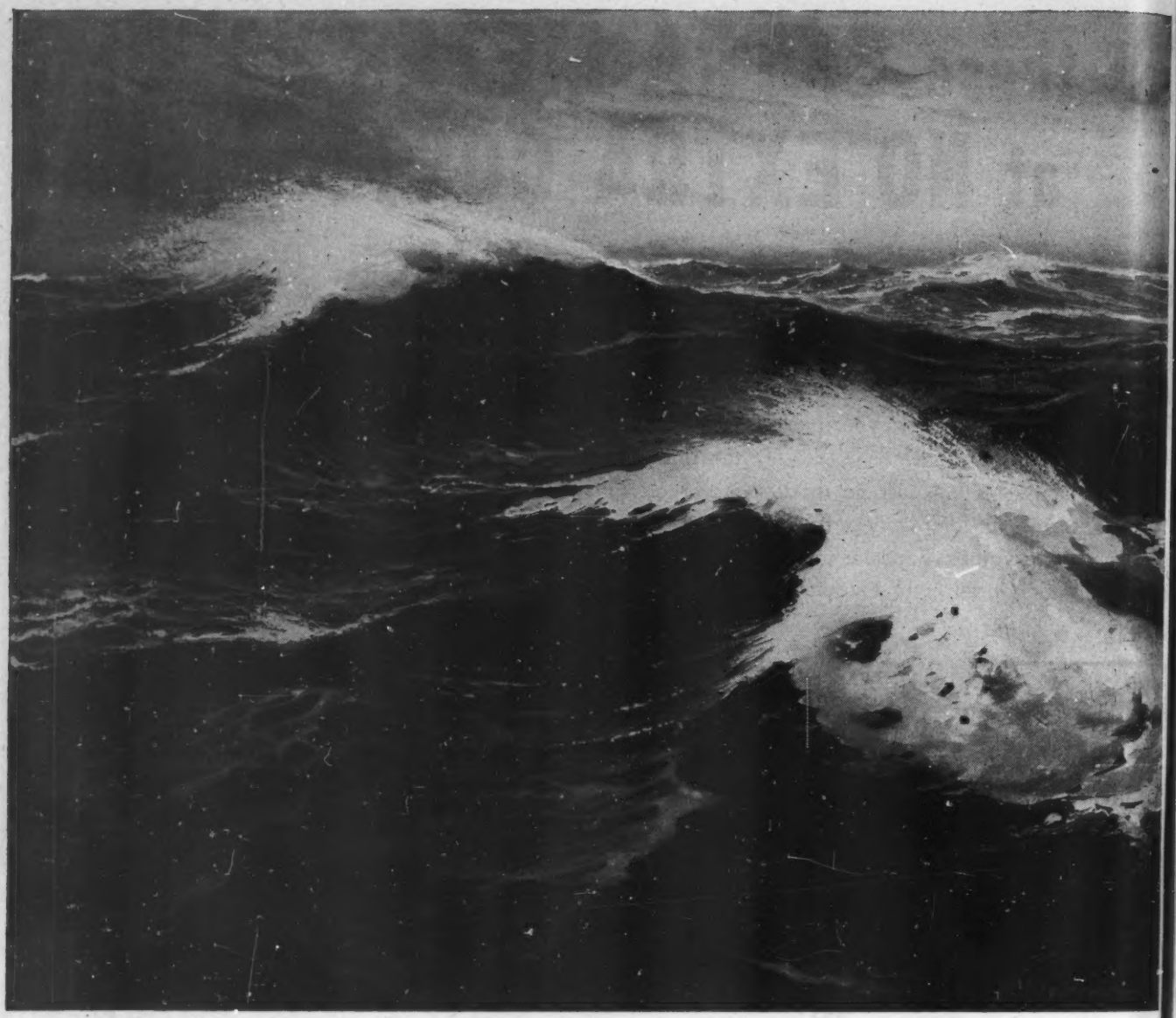
Damping plug eliminates effects of extreme pulsations in the line. Adjustable while meter is in operation.

Foxboro Flow Meters are made in recording, controlling, indicating and integrating models for all needs of process industries, gas suppliers, power plants and water works.

Foxboro engineers will be glad to place their specialized knowledge of flow measurement at your service for better metering installations. Write for detailed information. **The Foxboro Company, 74 Neponset Avenue, Foxboro, Massachusetts, U. S. A.** Branches in principal cities.

FOXBORO
REG. U. S. PAT. OFF.

MONEY-SAVING FLOW METERS



TROUBLED WATERS

Water can cause plenty of trouble in any cooling water system because of corrosion, scale, or biological fouling. Treatment by chemical means is imperative.

In applying chemical treatment to cooling water W. H. & L. D. BETZ offers a complete consulting engineering service, based on a wealth of experience in the field of industrial water conditioning. It is our function to first make an "on-the-spot" survey of conditions and then to submit recommendations for proper chemical treatment and control. It is literally our job to solve the problem of "troubled waters".

BETZ chemical engineers are strategically located throughout the nation. A discussion of your particular problem entails no obligation.

W. H. & L. D. BETZ • Frankford, Philadelphia, Penna.

● **CHEMICAL ENGINEERS AND CONSULTANTS ON ALL WATER PROBLEMS**

BETZ

FACTS... About

Postwar Refinery Economics

IT IS NOW virtually certain that immediately after the war competition will be severe. Consumers will demand improved quality in petroleum products. To meet all these overall market characteristics, M.W. Kellogg has already undertaken projects for the modernization of existing refineries to achieve specific objectives.

1. *With manufacturing costs lower than those for his prewar gasoline,* one Kellogg customer will increase his gasoline to 80-85 octane with less than 1 c.c. of lead.

2. Another Kellogg customer, whose distillates already meet postwar quality requirements, will produce 20% more of these profitable products—20% less of unprofitable residual oils—*with no increase in the total refining cost of finished products.*

THESE specific objectives of our customers are not inspired by the realm of theory. The process concepts to achieve them are commercially practical—proven in the Kellogg "pilot" refinery and now being finally engineered. Such projects, already under way, are a measure of the competitive "plus" that an M. W. Kellogg job can give to *any* refiner... regardless of the size of his operation.

THE M. W. KELLOGG COMPANY

★ *Only Kellogg Service Has Them All*

★ **LABORATORIES**—fully equipped and staffed—devoted exclusively to chemical engineering and process development.

★ **24-HOUR-A-DAY PILOT PLANTS**—17 refining processes operating continuously—providing accurate data for commercial scale application.

★ **EXCLUSIVE CHEMICAL ENGINEERING DATA**—Continuously compiled... embracing both pilot plant runs and the operation of Kellogg-built refineries. Data extends from beginning of modern refining.

★ **PROCESS ENGINEERS**—Specialists who have continuously made major contributions to oil refining development, for more than 20 years... currently exemplified by their work on fluid catalytic-cracking.

★ **MECHANICAL ENGINEERS**—Kellogg installations—worth hundreds of millions—are their best reference.

★ **METALLURGICAL LABORATORY**—Establishes continuous check of specifications...creates new techniques for the fabrication of refining equipment.

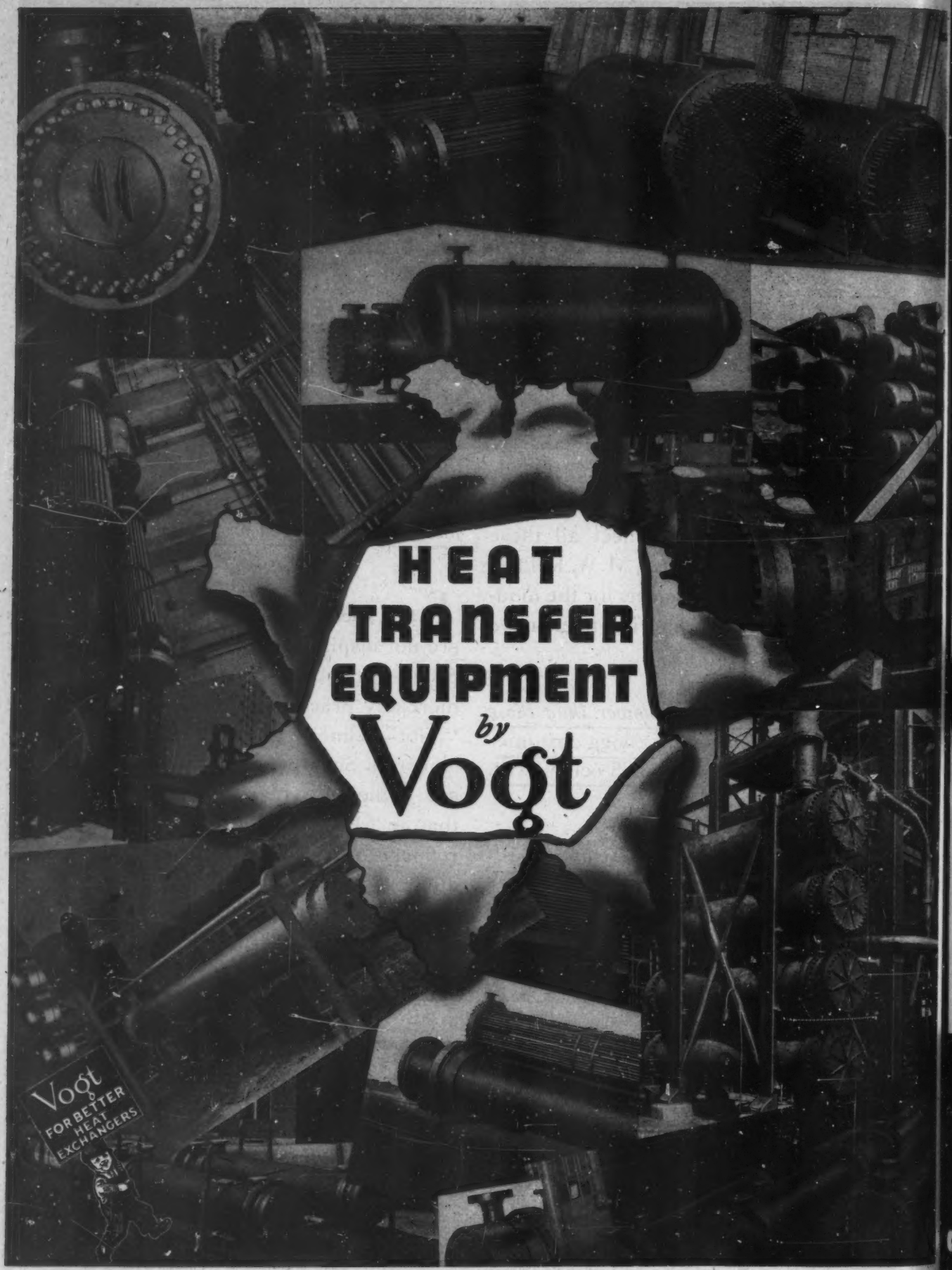
★ **PERMANENT CONSTRUCTION CREWS**—Geared to function all over the world on single units or multiphase refineries... team-experience cuts costs, speeds construction.

★ **OPERATING STAFFS**—Specialists at placing new units "on stream"... training of refiner's own operating crews.

★ **LICENSING SERVICE**—Licenses available through Kellogg as Licensor or licensing agent for all types of refining processes.

KELLOGG

225 Broadway, New York 7, N. Y. • Jersey City, N. J. • 809 Grand Ave., Los Angeles, Calif. • Philtower Bldg., Tulsa, Okla. • 402 Esperson Building, Houston 2, Texas • Stone House, Bishopsgate, London, EC2



HENRY VOGT MACHINE CO., Inc., LOUISVILLE, KY.

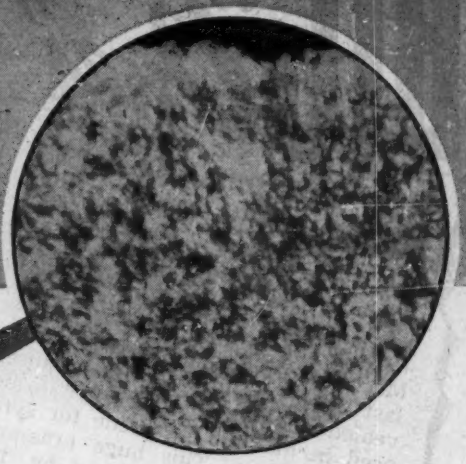
NEW YORK • PHILADELPHIA • CLEVELAND • CHICAGO • DALLAS

Natural Montmorillonite Structure

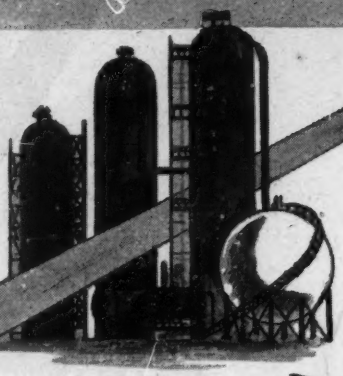
(CHEMICALLY TREATED)

Gives FILTROL* Superior Porosity!

Assures these fine commercial results . . .



Microphotographs of thin sections made from actual FIL ROL Catalyst pellets. Enlargement approximately 180x.

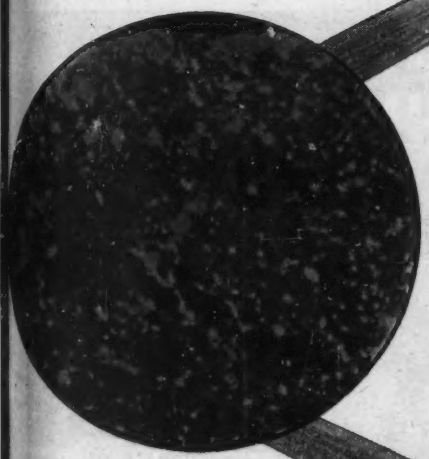


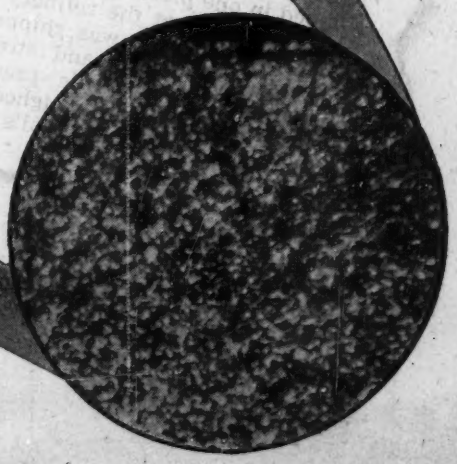
1. *BEFORE USE . . .*

Showing prepared, crystalline Montmorillonite structure — chemically processed to assure superior porosity.

2. *USED . . .*

This superior porosity provides scores of acres of surface area—assures maximum "loading" through to the core and easy release of conversion products.





3. *REGENERATED*

Natural strength and stability—with pore size that allows full air access for interior and surface carbon burning—permits maximum regeneration of the entire pellet, insures uniform results in repeated re-use.

FILTROL

CATALYSTS and ADSORBENTS

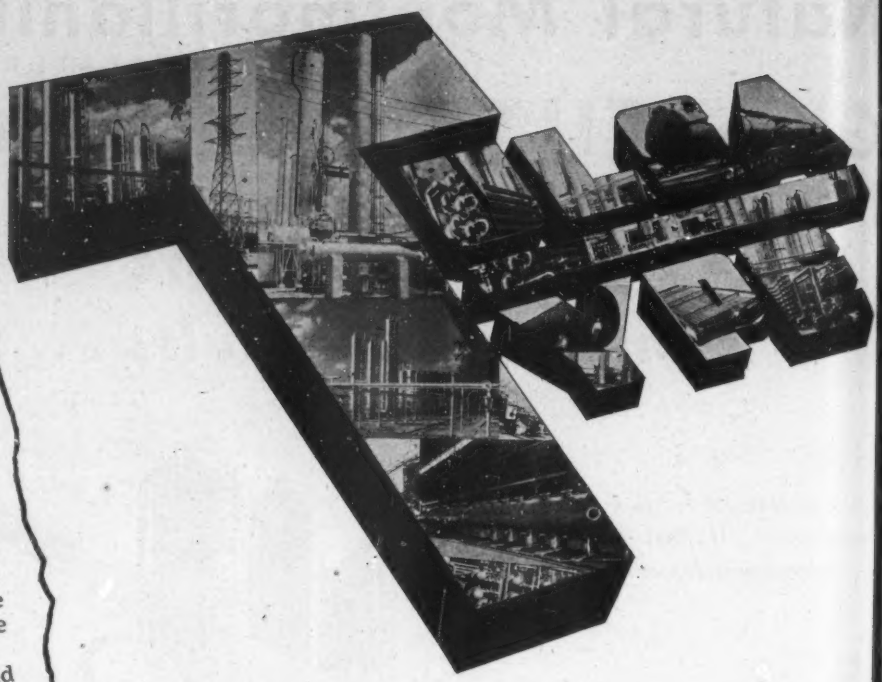
FILTROL CORPORATION

GENERAL OFFICES: 634 S. Spring Street, Los Angeles 14, California

PLANTS: Vernon, Calif., Jackson, Miss.

*Reg. U. S. Pat. Off.

When it comes to BIG "Ones"



Big Fractionating Tower Shipped in One Piece

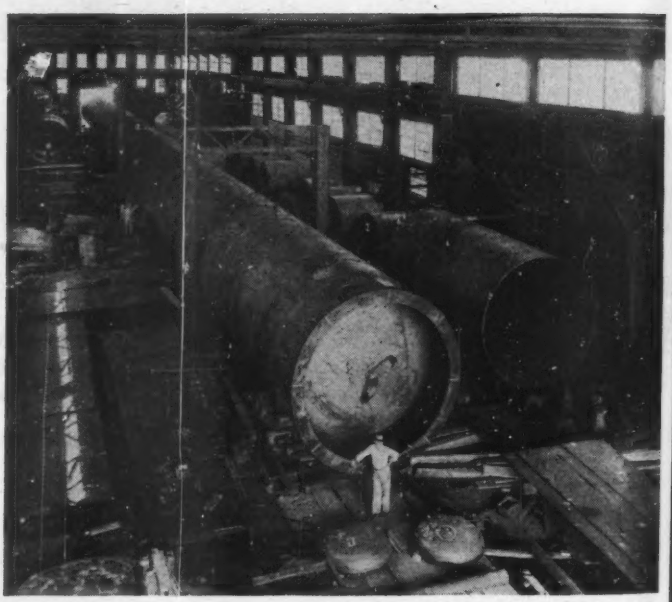
A fractionating tower 13½ by 150 ft. and weighing 250 tons, the biggest ever shipped in one piece, moved out of the Tulsa Boiler & Machinery Co. plant in West Tulsa last week, on its way to an unrevealed destination, where it is to be used in making butadiene for synthetic rubber. This huge pressure tank is one of two ordered by the same refinery.

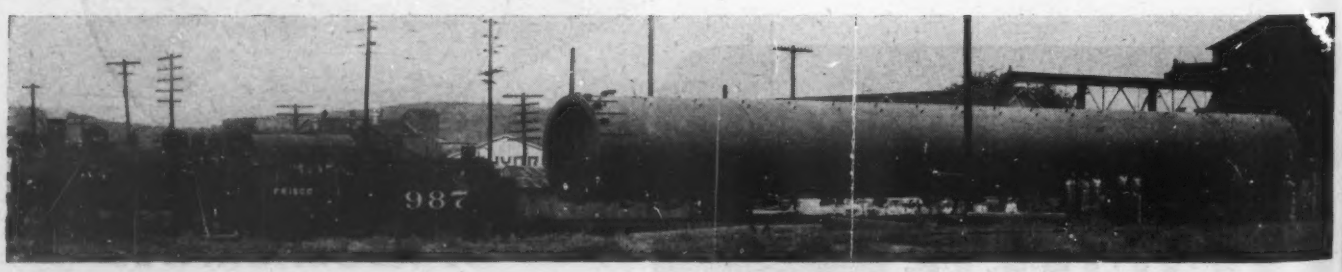
The 150 ft. of tank was shipped on three special railroad flatcars equipped with heavy cradles. The weight was supported by pivots on the two end cars, the third car running between as an idler.

Because the tank itself is 13½ ft. in diameter, it was necessary to use a railroad route which would give sufficient clearance for the tank plus the height of the car — a total of nearly 20 ft. In many sections of the country bridges or tunnels would be too small to permit passage.

Officials of the Tulsa Boiler & Machinery Co. said that though larger fractionating towers have been built, none has ever been shipped in one piece. The parts have been assembled at the refinery site.

Before the tower was shipped it was tested for leaks and strength under heavy hydrostatic pressure. When full of water, it weighed just under 2,000,000 lb. Its walls were rolled from 1⅛-in. steel.



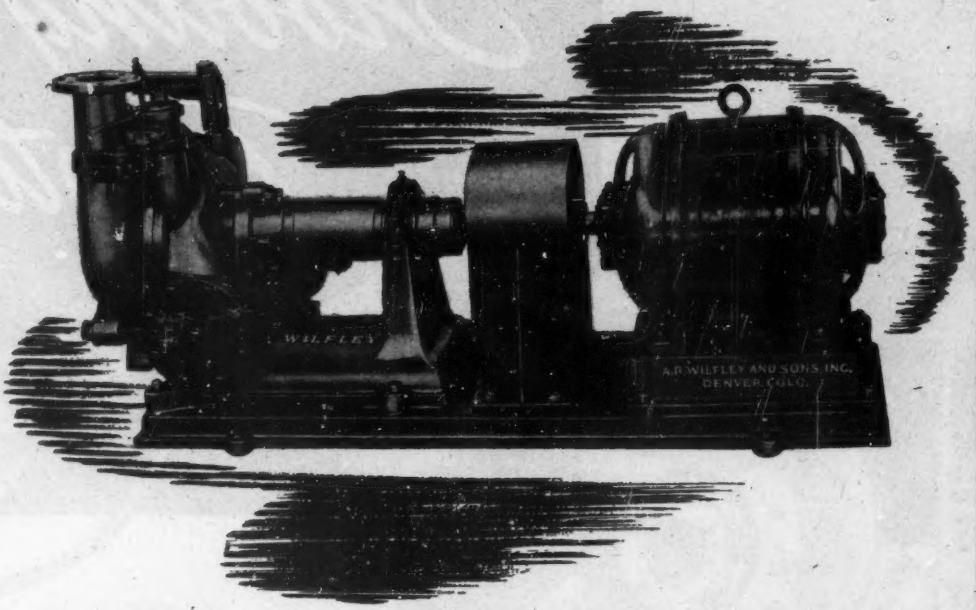


TULSA BOILER & MACHINERY CO.

TULSA 1, OKLAHOMA

EXPORT OFFICE: Room 1940, 30 Rockefeller Plaza

NEW YORK CITY 20, NEW YORK

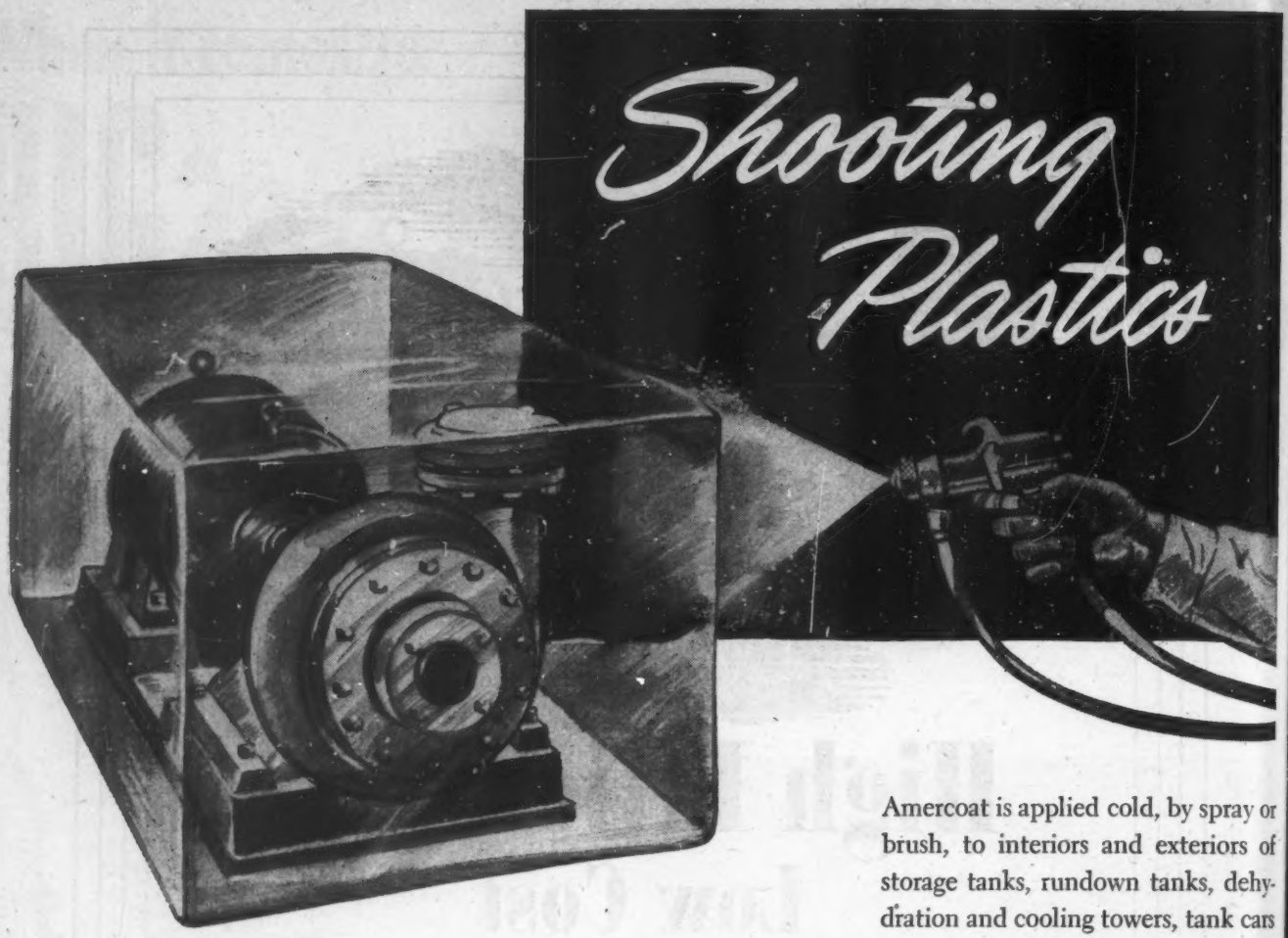


High Efficiency
Low Cost

Three-shift performance without attention—CONTINUOUS high efficiency—are characteristic of the WILFLEY sand pump. It's a reputation based on actual production records for handling sand, slimes and slurries in the world's most efficient plants. Heavy pumping parts of rubber, alloy iron, alloy steel—whatever material best suits your particular job. WILFLEY is the pump to buy if you want true high efficiency. *Individual engineering service on every application.* Write or wire for full details.

WILFLEY

A.R.WILFLEY & SONS, Inc., Denver, Colo. U.S.A.
New York Office: 1775 Broadway, New York City



. . . to Save Money!

Quickly and easily, an ordinary spray gun shoots Amercoat Plastic Coating on refinery equipment or structures.

Result? Positive protection against corrosion. That equipment or structural surface is encased in a tough, durable plastic skin that is impervious to hydrogen sulphide, salt water, caustic soda, sour crudes, sulfuric acid, and other corrosive salts, acids and alkalies.

Waste and wear, costly maintenance and replacement are reduced to a minimum. Efficient operation is safeguarded; vital facilities conserved; time and money saved.

Amercoat is applied cold, by spray or brush, to interiors and exteriors of storage tanks, rundown tanks, dehydration and cooling towers, tank cars and trucks, gas scrubbers, waste and salt water disposal lines, acid and caustic soda pumps, tanks, sumps, and other refinery equipment.

Amercoat also prevents *contamination* of hi-octane gasoline, diesel oil, other refined oil products. It is odorless, tasteless, chemically inert; dries rapidly, requires no baking.

Get the facts about Amercoat *dual* protection in terms of your corrosion-contamination problems.

Write for illustrated booklet

YOUR ASSURANCE OF 100% RESULTS

Your letter explaining your particular problem will receive the attention of our technical staff. Amercoat will be recommended for your use *only* after thorough analysis or past experience definitely proves its practical value. Descriptive booklet sent on request.

MANY INDUSTRIES USE AMERCOAT PROTECTION,

such as:	BOTTLING	CHEMICAL	SHIPBUILDING
MARINE	HOSPITAL	DISTILLING	PHOTOGRAPHIC
FOOD	FISHING	CONCRETE	PETROLEUM
SOAP	MINING	CANNING	CONSTRUCTION
WINE	LAUNDRY	AVIATION	TRANSPORTATION
DAIRY	BREWING	BEVERAGE	SEWAGE DISPOSAL

"A NAME EVERY REFINER SHOULD KNOW"

Amercoat

AMERCOAT DIVISION
AMERICAN PIPE AND CONSTRUCTION CO.
P.O. Box 3428, Terminal Annex, Los Angeles 54, California

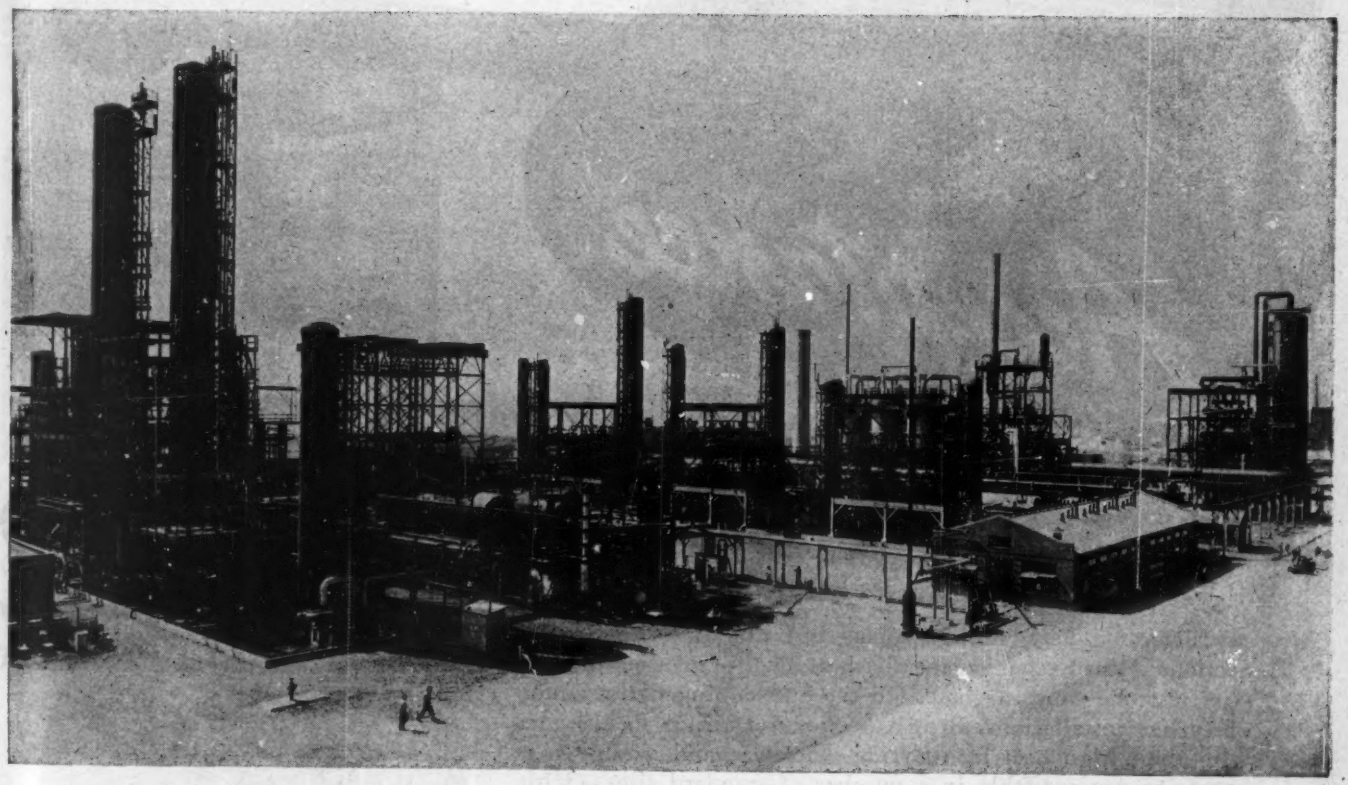
PRESSURE VESSELS

for

OIL REFINERIES

and

CHEMICAL PLANTS

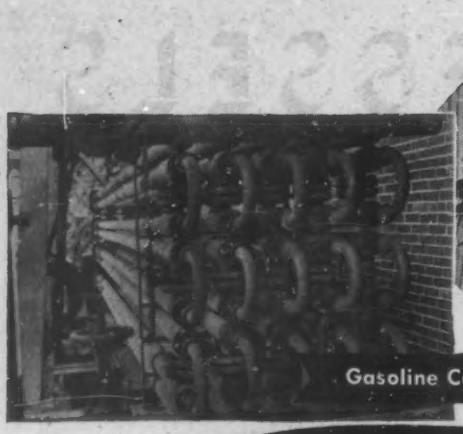


SUN SHIPBUILDING & DRY DOCK CO.

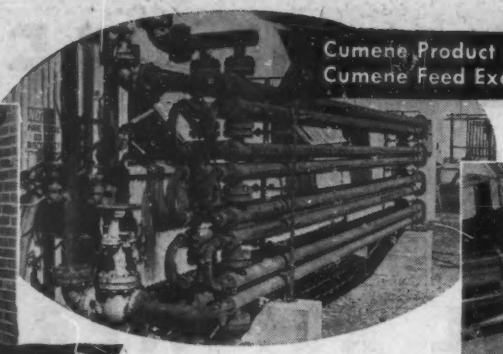
SHIP AND ENGINE BUILDERS **SHIP REPAIRING**

OIL REFINING EQUIPMENT

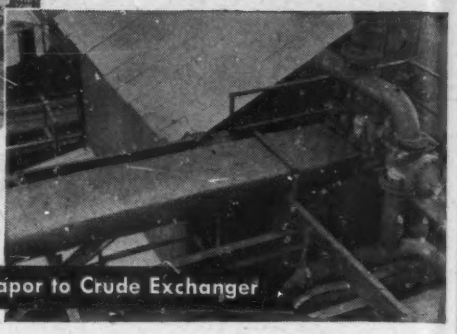
CHESTER, PA.



Gasoline Cooler



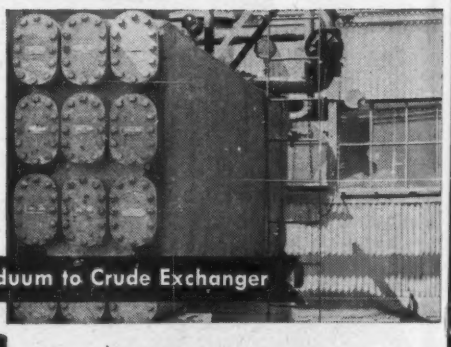
Cumene Product to Cumene Feed Exchanger



Gas Oil Vapor to Crude Exchanger

BROWN FINTUBE'S

Acceptance



Residuum to Crude Exchanger

..is based on Performance

● Illustrated herewith are some—but not all—the Brown Sectional Heat Exchanger installations made—one after another—by just one concern—based on the outstanding performance of earlier installations. Brown Sectional Hairpin Exchangers with their high heat transferring efficiency, and trouble free operation are available in a number of standard sizes,—with different numbers and depths of fins to meet different requirements. The sections mount easily into tight, compact "banks," assure positive inspection and easy maintenance,—meet every requirement of the engineering, operating and maintenance departments. Fully descriptive literature, recommendations, and quotations furnished promptly.

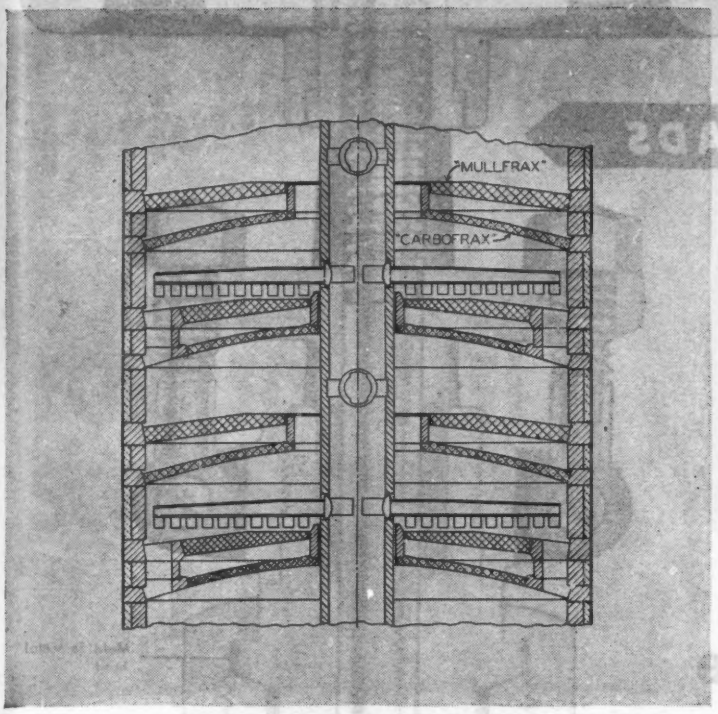
Diesel Oil Side Stream to Crude Exchanger

THE BROWN FINTUBE CO.

121 FILBERT STREET • ELYRIA, OHIO

MANUFACTURERS OF INTEGRALLY BONDED FINTUBES AND FINTUBE HEAT EXCHANGERS

NO. 2 IN A SERIES DESCRIBING THE USE OF SUPER REFRACTORIES IN THE PROCESS INDUSTRIES



The temperature is high

The charge is corrosive

▶ Resistance to *corrosion* frequently joins resistance to *high temperatures* as a "must" for refractories used in chemical processing equipment.

Take a multi-hearth muffle furnace of the above type, for example. The arches are made of "Carbofrax"—the silicon carbide super refractory by Carborundum that does not soften at the operating temperatures encountered. It is particularly resistant to flame erosion and possesses high mechanical strength at elevated temperatures. It's used here to eliminate frequent, untimely shutdowns for refractory replacements.

And with a thermal conductivity *11 to 12 times that of fire clay*, "Carbofrax" provides the rapid, uniform heat flow so necessary to economical furnace operation.

"Mullfrax"—electric furnace mullite—is used to form hearths that stand up when roasting corrosive ores or materials of similar nature. Chemically stable, exceptionally resistant to abrasion, and having excellent load-carrying strength at high temperatures, this super refractory is long lived—thus lower operating costs and continuous service are ensured.

Many processes in the chemical, metallurgical and petroleum industries have been made practicable or more efficient through use of *Carborundum Brand* super refractories. Used as linings for gas generators, still settings, rabble blades, vertical retorts, furnace linings, etc., they have consistently meant longer life . . . less maintenance . . . lower operating costs.

Call on Carborundum whenever high temperature problems arise. Qualified Refractories Engineers will work with you to determine if *Carborundum Brand* super refractories can be used to make a proposed process practicable—or an existing process more efficient.

THE CARBORUNDUM COMPANY
Refractories Division, Perth Amboy, N. J.

District Sales Branches: Chicago, Philadelphia, Detroit, Cleveland, Boston, Pittsburgh. **Distributors:** McConnell Sales & Engineering Corp., Birmingham, Ala.; Christy Firebrick Company, St. Louis, Mo.; Harrison & Company, Salt Lake City, Utah; Pacific Abrasive Supply Company, Los Angeles & San Francisco, California; Denver Fire Clay Company, El Paso, Texas; Smith-Sharpe Company, Minneapolis, Minn.

"Carborundum," "Carbofrax" and "Mullfrax" are registered trade marks of, and indicate manufacture by, The Carborundum Company

Super Refractories by CARBORUNDUM
TRADE MARK

SEND FOR *this booklet and learn how super refractories are used in the process industries. Gives helpful charts of properties and many interesting applications.*

Clip coupon now!

THE CARBORUNDUM COMPANY, Refractories Division, Perth Amboy, N. J.
Please send me a copy of "Super Refractories for the Process Industries."

Name_____
Title_____
Company_____
Address_____
City_____ State_____

QUICK-ACTING THREADS

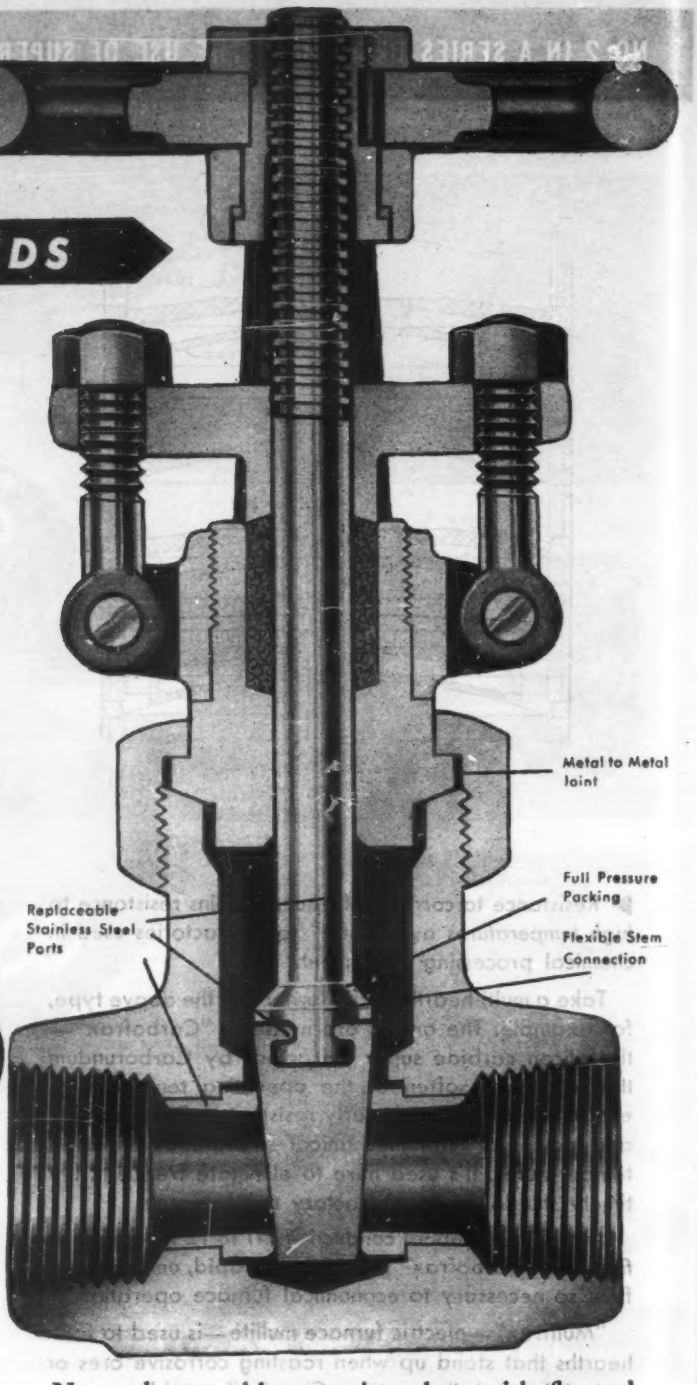
NOW ENTIRELY

PROTECTED

The new

CHAPMAN

List 960 Gate Valve



You can expect longer service from this new small forged steel gate valve (which replaces Chapman's Standard List 960). These features *insure* it:

Bonnet now fitted with a substantial forged steel yoke. A flanged forged steel packing gland is provided, thereby eliminating exposed threading on valve yoke, thus giving immunity from rusting and corrosion when placed in exposed locations.

Stems, plugs, and seat rings *on all valves* are heat treated stainless steel to insure greater working qualities.

Swivel bolts are used for holding the packing gland.

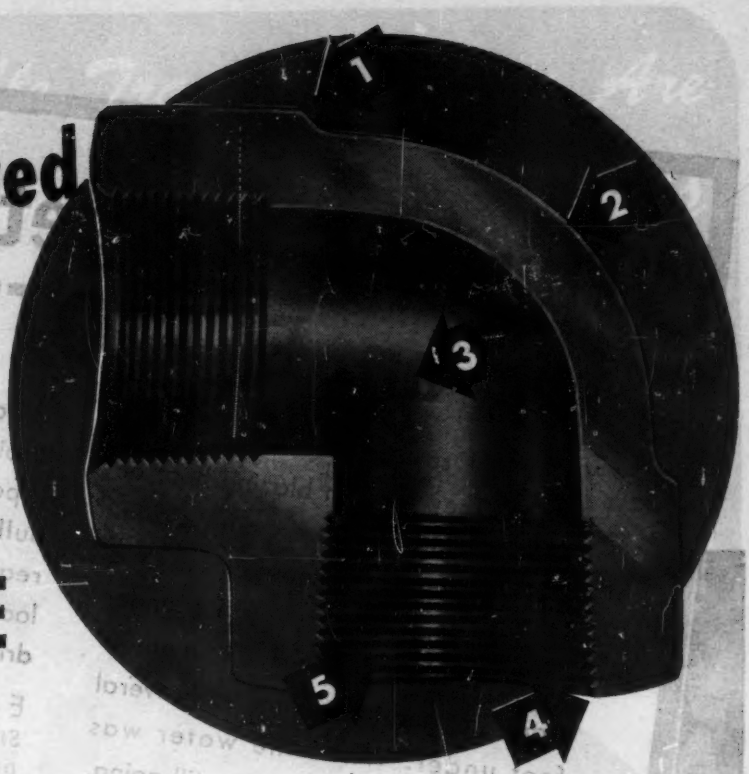
No gaskets to blow, as in valves with flanged bonnet connections.

Specify List 960 outside screw type in carbon steel for working pressures to 800 lbs. at 750° F. Or in alloy steel for service at 1000 lbs. working pressure at 750° F. Both valves available in screw and welding ends. Where service conditions make it preferable the List 960 rising stem inside screw type is available.

For greater pressures — get Chapman List 990 with heavier walls and extra strength. In sizes up to and including 1½", with screw or welding end.

The Chapman Valve Mfg. Co., Indian Orchard, Mass.

Time Tested and Performance Proved



FORGED STEEL SCREW END PIPE FITTINGS

AVAILABLE IN 2000–3000 AND 6000 POUND CLASSES FOR OIL–GAS–STEAM–AMMONIA AND HYDRAULIC SERVICE

• W-S Forged Steel Fittings are especially recommended for High Pressure, High Temperature Service in refineries, oil fields, chemical plants, shipyards, air conditioning and refrigeration plants, power plants and all hydraulic services.

WHY W-S FITTINGS ARE PREFERRED

1. Long low bands extending beyond thread provide strength where necessary to insure tight joints as well as ample wrench surface for easy installation.

2. A high safety factor is insured through heavy walls of uniform thickness.

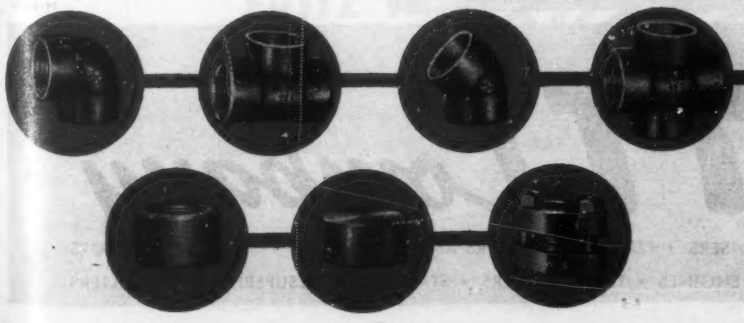
3. Unrestricted flow is provided by passages greater in area than the pipe of equivalent size.

4. All Fittings are chamfered to protect the thread and afford easy entrance of the pipe.

5. Threads are long, accurately cut—perfectly aligned insuring tight joints.

W-S Forged Steel Screw End Fittings are machined from solid drop forgings. Available in three classes—2000—3000—and 6000 pound. Sizes ¼" to 4" I. P. S. Each class can be furnished in Carbon Steel; Carbon-Molybdenum Steel; Chromium-Molybdenum, Steel or Stainless Steel. Ask for Bulletin A-3. The Watson-Stillman Co., Roselle, New Jersey.

Sold Through Leading Distributors



WATSON-STILLMAN

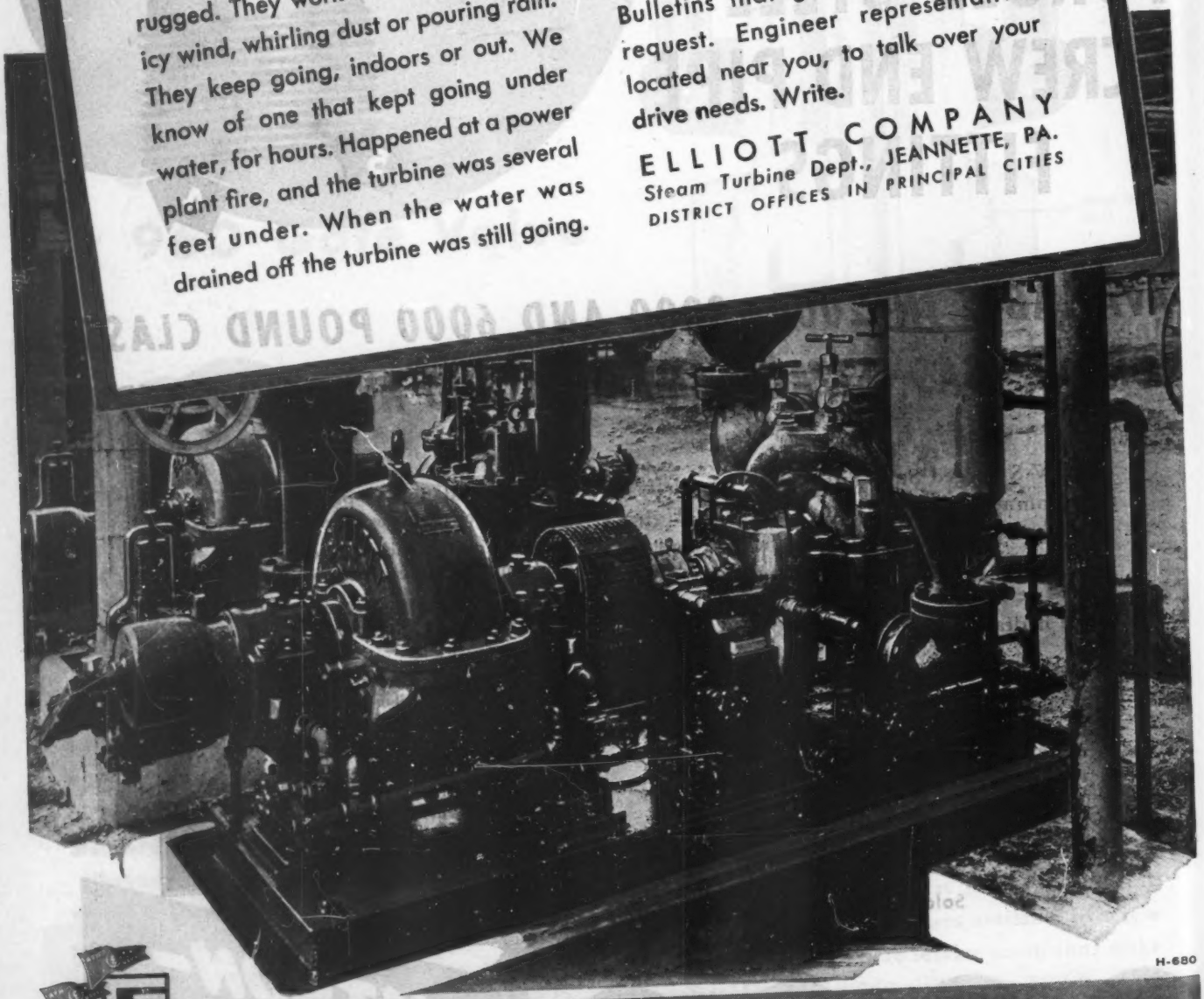
DESIGNERS AND MANUFACTURERS OF FORGED STEEL FITTINGS, VALVES AND HYDRAULIC EQUIPMENT

"Things never get too tough for an ELLIOTT turbine"

You might say they are brought up rugged. They work in blazing heat or icy wind, whirling dust or pouring rain. They keep going, indoors or out. We know of one that kept going under water, for hours. Happened at a power plant fire, and the turbine was several feet under. When the water was drained off the turbine was still going.

Good turbines for tough jobs. Good turbines for any auxiliary drive job. Types for all needs within broad range. Bulletins that give full details, at request. Engineer representatives located near you, to talk over your drive needs. Write.

ELLIOTT COMPANY
Steam Turbine Dept., JEANNETTE, PA.
DISTRICT OFFICES IN PRINCIPAL CITIES



H-680

ELLIOTT Company

STEAM TURBINES • GENERATORS • MOTORS • CONDENSERS • FEEDWATER HEATERS AND DEAERATORS • STEAM JET EJECTORS
CENTRIFUGAL BLOWERS • TURBOCHARGERS FOR DIESEL ENGINES • TUBE CLEANERS • STRAINERS • DESUPERHEATERS • FILTERS

In GLITSCH Bubble Trays and Caps Are Latest Fabricated Improvements

Fabricated structural major beam.

Trapezoid minor trusses.

Thermal expansion joint between deck plates and supporting trusses.

Peripheral tray clamps.

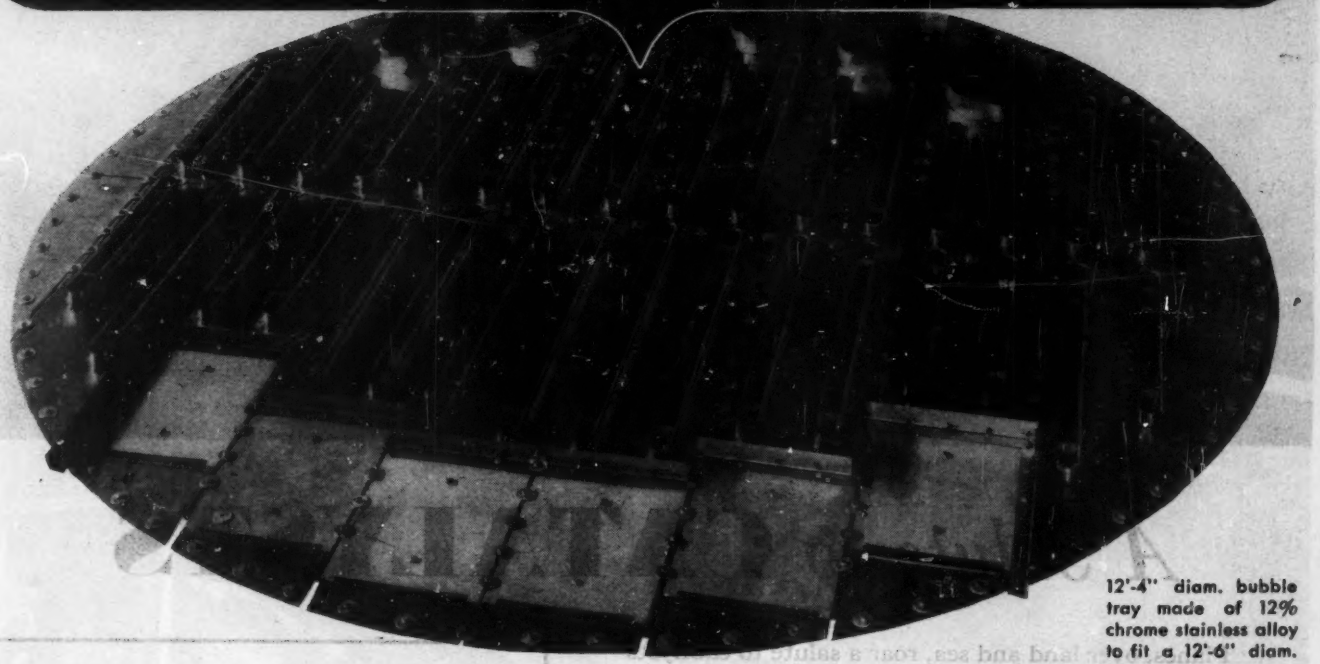
Improved bolting arrangements for holding caps to decks.

Extruded holes in deck plate and "set-on" riser.

Simplified installation of downcomer plates.

Adjustable weirs.

Something Special? . . . Call in GLITSCH



12'-4" diam. bubble tray made of 12% chrome stainless alloy to fit a 12'-6" diam. tower.

GLITSCH Bubble Trays and Caps are designed to meet process demands, vessel designs, corrosive and thermal conditions, and installation problems, as well as provide for easy inspection and inexpensive maintenance. These are all met by improved design that incorporates the above features. All equipment is laid out on blue prints and then submitted for approval. There is no obligation attached to confidential discussion with GLITSCH representatives at any time.

Manufactured under U. S. Patents No. 2,210,808; No. 3,309,309 No. 2,338,928 and No. 2,341,091, and other Patents Pending

FRITZ W. Glitsch & SONS

"TRUSS-TYPE" BUBBLE TRAYS . . . and CAPS

HOME OFFICE and PLANT DALLAS 1, TEXAS

New York City office
SALMON TOWER BUILDING
11 WEST 42nd STREET

Mid-Continent Area Representatives
W. C. MYERS & COMPANY
Tulsa Logn Bldg. Tulsa 3, Okla.
Chicago Office:
310 S. Michigan Ave.

Gulf Coast Representatives
K. E. LUGER COMPANY
Heights State Bank Bldg.
3618 Washington Ave.
Houston 7, Texas

Pittsburgh Area Representatives
D. D. FOSTER COMPANY
412 Peoples Gas Building
Pittsburgh 19, Pa.

A Salute to CATALYSTS

Planes, over land and sea, roar a salute to catalysts and to the refining industry . . . the combination which has accomplished the seemingly impossible . . . in producing large quantities of high octane gasoline in record time.

From the start, The Harshaw Chemical Company participated in this enormous job by supplying catalysts for ALKYLATION, ISOMERIZATION, DEHYDROGENATION, HYDROFORMING, HYDROGENATION, POLYMERIZATION, DEHYDRATION.

The potential uses for catalysts are unlimited. All indications point to increased possibilities for wider industrial uses in manufacturing applications not yet explored.

Samples are available for test purposes.

TYPICAL CATALYSTS

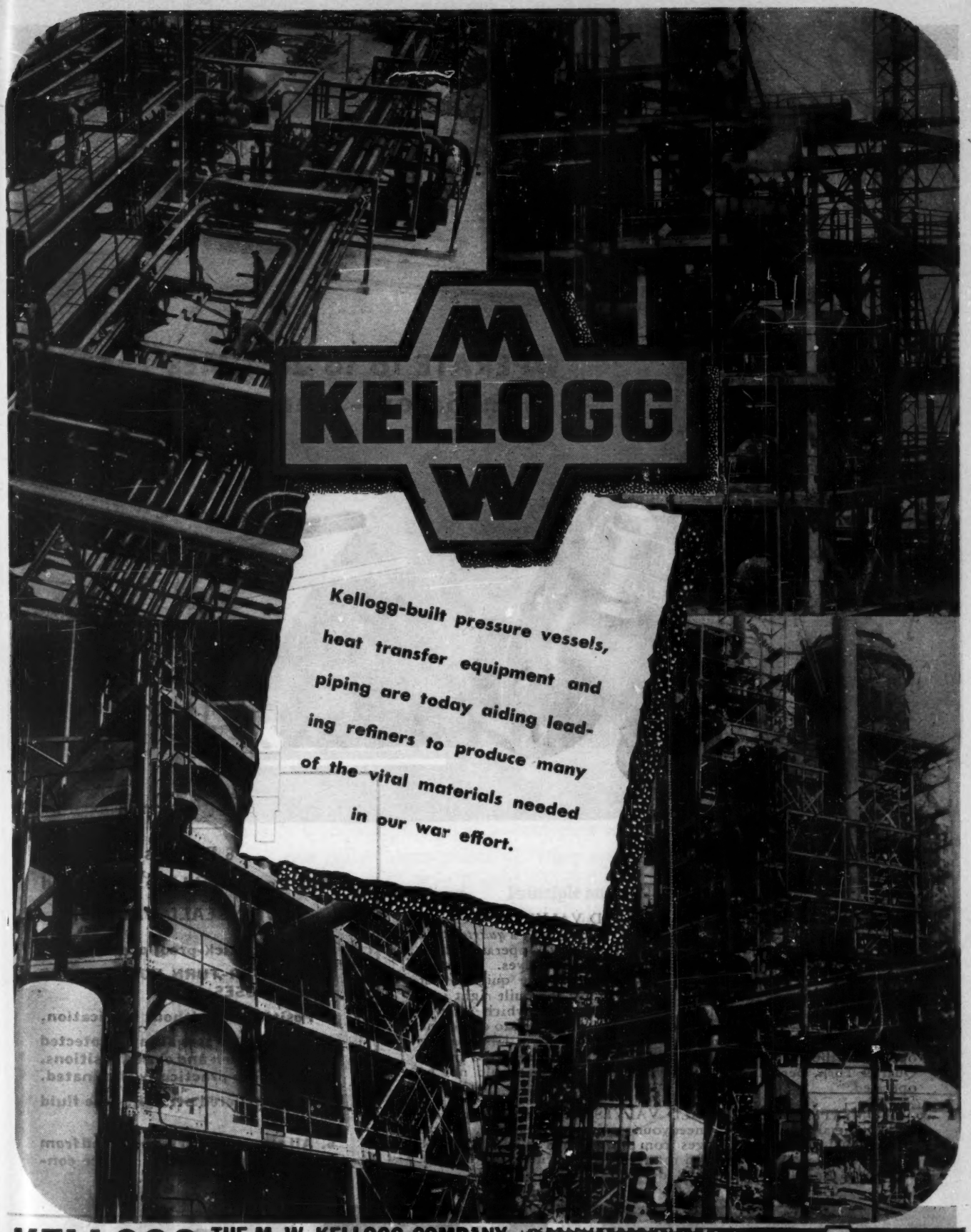
Anhydrous Hydrofluoric Acid • Aluminum Chloride
Boron Trifluoride • Anhydrous Hydrochloric Acid

Activated Alumina	Molybdenum Alumina
Chrome Alumina	Tungsten Alumina
Chrome	Nickel
Cobalt	Phosphates
Iron	Thorium
Magnesia	Titanium
Molybdenum	Tungsten

We have a large capacity for pelleting

HARSHAW

THE HARSHAW CHEMICAL CO.
1945 East 97th Street, Cleveland 6, Ohio
BRANCHES IN PRINCIPAL CITIES


M
KELLOGG
W
Kellogg-built pressure vessels, heat transfer equipment and piping are today aiding leading refiners to produce many of the vital materials needed in our war effort.

KELLOGG

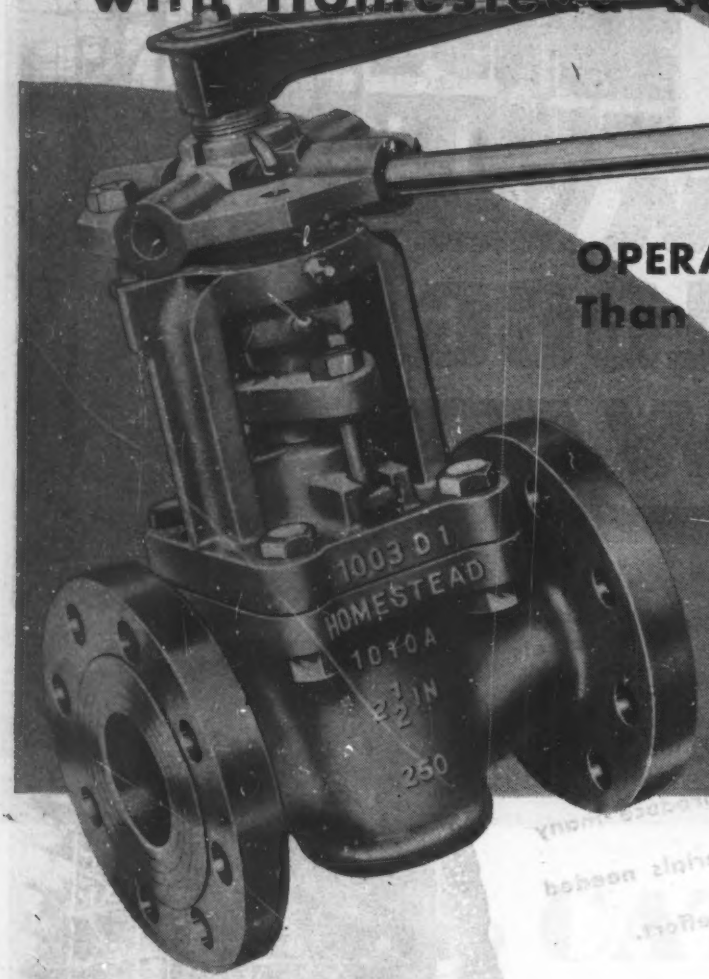
THE M. W. KELLOGG COMPANY
Jersey City, N. J. • 225 Broadway, New York 7, N. Y.
Representatives:
LOS ANGELES: 609 SOUTH GRAND • TULSA: PHILTOWER BLDG.

M KELLOGG W

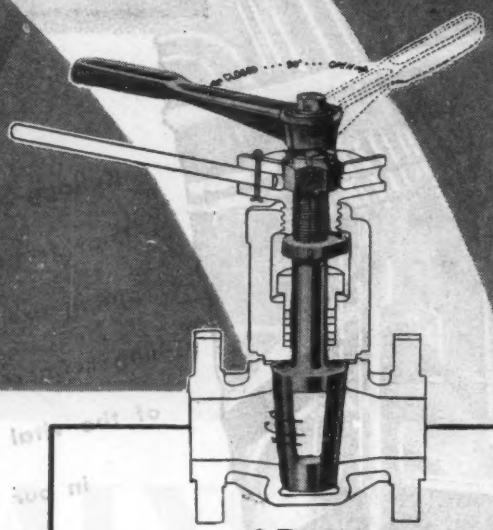
"Masterflex" Prefabricated Piping Systems • "Masterweld" pressure vessels for Power, Refinery and Chemical Industries. Heat Exchangers. Pyrolytic and Catalytic Cracking Units, Hydroforming, Reforming, Dehydrogenation, Alkylation, Desulphurization. Thermal and Catalytic Polymerization Units • JUIK Processes for Lubricating Oil Plants. Plastic Refractories • Radial Brick Chimneys.

Quick Action Every Time

with Homestead Lever-Seald Valves



OPERATE 16 to 28 TIMES FASTER
Than Screw-Stem Type Valves



Operation of HOMESTEAD LEVER-SEALD VALVES is quick and positive. From wide-open to fully-closed requires only a *quarter-turn* of the upper lever—and that's 16 to 28 times faster operation than the 6 to 7 full turns required by screw-stem-type valves. Not only do HOMESTEAD LEVER-SEALD VALVES operate quickly, but they are built to operate under all conditions; for built right into every valve is a powerful lever and screw device which relieves seating pressure between the plug and body just enough to overcome friction and permit easy turning. For fast, positive, labor-saving operation, they can't be beat! And the small space required by the Quarter-Turn, permits their use where other valves could not be operated.

HOMESTEAD LEVER-SEALD VALVES are made in combinations of metals and alloys to meet your service requirements, in sizes 1⅛" to 10", for pressure ranges from 150 pounds to 1500 pounds. Special valves may be designed to meet your specific requirements. Write *now* for Valve Reference Book No. 38.

6 Reasons

Why You Should Use Homestead

LEVER-SEALD VALVES:

1. **Instant Stick-proof operation.**
2. **QUARTER-TURN FULLY OPENS OR CLOSES.**
3. **Positive seal without lubrication.**
4. **Seating surfaces always protected in both open and closed positions. Corrosion practically eliminated.**
5. **Unobstructed straight-line fluid flow.**
6. **All operating parts protected from damaging effects of service conditions and weather.**

Homestead VALVES
LEVER-SEALD

"M" Pennant with three additional gold stars—highest Maritime production award yet given to the men and women of any manufacturing company.

HOMESTEAD VALVE MFG. CO. • • • P. O. BOX 16 • • • CORAOPOLIS, PA.

IT *STAYS* ACCURATE

Sustained **accuracy through long periods of hard service—that's what you want in a petroleum meter for pipe line and refinery service. And that's what you *get* in a *Smith Meter*.**

The metering mechanism is fortified against pressure shock. The simple, time-tested Smith Rotary Principle and exclusive Smith design provide an unequalled combination of *speed, stamina,* and accuracy that *stays* accurate.

★ ★ ★

Available on priority for every pipe line and refinery need in capacities from 57 to 929 barrels per hour . . . and for pressures from 250 lbs. p.s.i. to 1000 lbs. p.s.i.

SMITH METER COMPANY

SUBSIDIARY OF A. O. SMITH CORPORATION

Factories at Los Angeles and Milwaukee

SALES OFFICES AT NEW YORK • CHICAGO • HOUSTON • LOS ANGELES

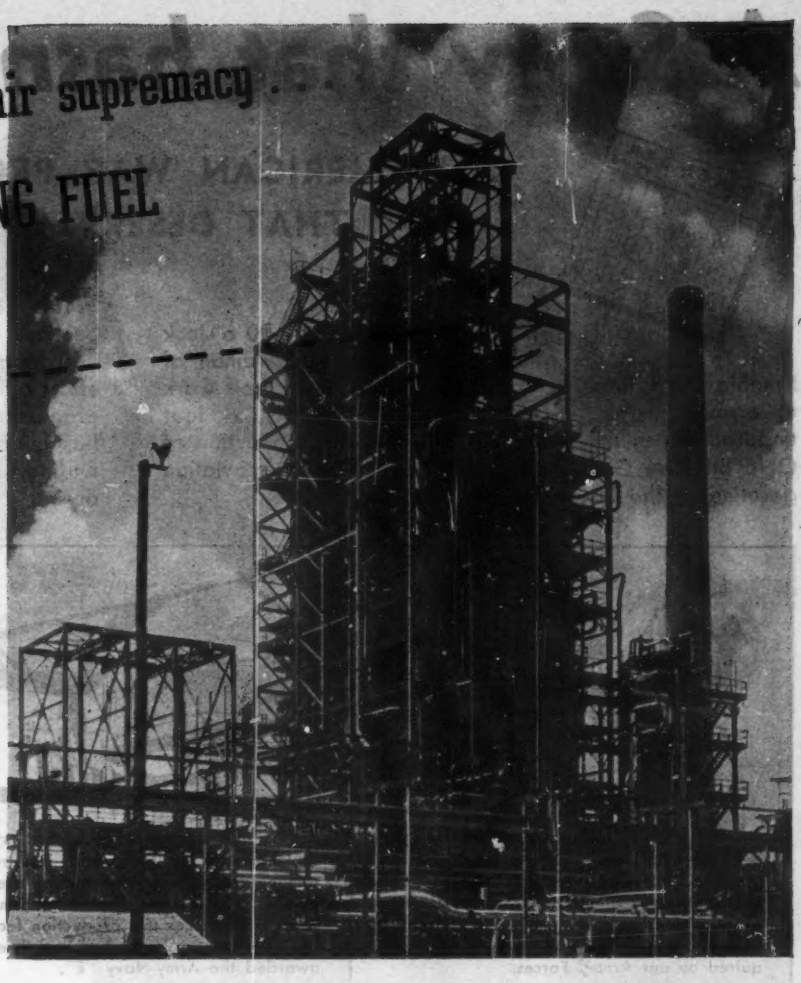
Forty-one years before the 19th Amendment permitted national women's suffrage, fair voters were casting ballots in municipal elections at the Massachusetts polls. In steam engineering, too, in 1879, something new had been added. Tim Kieley introduced the steam trap... the daddy of them all. For 3 generations since then, K & M Specialties have benefitted from this pioneering headstart. Today's K & M Type 554 combination Back Pressure and Atmospheric Relief Valve is an example. In any service where constant pre-determined back pressure and absolutely tight shut-off are required, this water-sealed valve is *guaranteed* against leakage or back flow. Sizes from 2″ to 24″, to handle pressure from 2 to 30 lbs. without pounding or chattering. Installation may be vertical or horizontal; pressure setting is easily adjusted; servicing, when necessary, is extremely simple. Type 554 may be *your* answer to an unsolved problem.

Do you have our General Catalog #66? Write for it.

KIELEY & MUELLER, INC.
MANUFACTURERS OF PRESSURE AND LEVEL CONTROLS SINCE 1879
NORTH BERGEN, NEW JERSEY

Towers of American air supremacy . . .

Birthplace of FIGHTING FUEL



SOLVAY

TRADE MARK REG. U. S. PAT. OFF.

49-50%

tank car

LIQUID

CAUSTIC POTASH

Gasoline powers the attack! . . . and helping to give high octane gasoline its fighting power is SOLVAY LIQUID CAUSTIC POTASH.

Produced with a KOH content of approximately 50%, it meets the needs of refiners for a high quality alkali with *an absolute minimum of impurities.* Prompt shipments in tank cars from our Syracuse plant.

Solvay can meet your requirements . . . Write today!

SOLVAY SALES CORPORATION

Alkalies and Chemical Products Manufactured by The Solvay Process Company

40 RECTOR STREET NEW YORK 6, N. Y.

BRANCH SALES OFFICES:

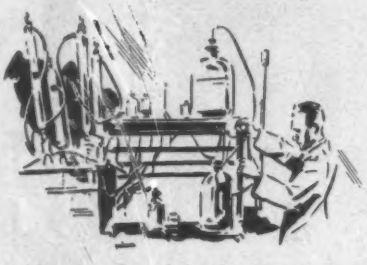
Boston 9, Mass.	45 Milk Street
Charlotte 2, N. C.	212 South Tryon St.
Chicago 2, Ill.	1 North LaSalle Street
Cincinnati 2, Ohio	3008 Carew Tower Building
Cleveland 15, Ohio	926 Midland Building
Detroit 32, Mich.	7501 West Jefferson Avenue
New Orleans 12, La.	1101 Hibernia Building
New York 6, N. Y.	40 Rector Street
Philadelphia 7, Pa.	12 South 12th Street
Pittsburgh 19, Pa.	1107 Gulf Building
St. Louis 8, Mo.	3615 Olive Street
Syracuse 1, N. Y.	Milton Avenue

A Story that hasn't been told

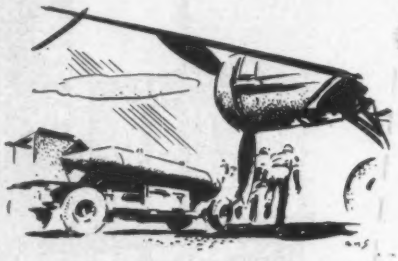
AN AMERICAN WAR PRODUCTION RECORD THAT DESERVES TELLING . . .

On December 14, at 3:00 o'clock in the afternoon, the men and women of Humble Oil & Refining Company will pause in their work to commemorate, in appropriate ceremony, a feat unparalleled in the petroleum industry: The production of ONE BILLION GALLONS of finished 100-octane aviation gasoline at the Baytown refinery.

This accomplishment merits special commendation, because it climaxes 25 years of development, planning, and teamwork of a great organization. The cooperative effort of Humble employees has brought about a uniform progress in all phases of the Company's operations which has enabled them to establish remarkable records in finding, producing, transporting and refining petroleum during a critical period in the history of our nation.

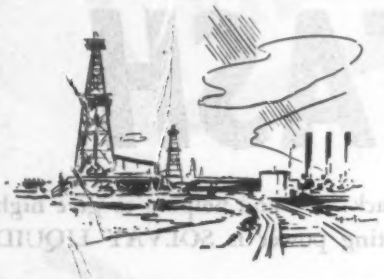


Humble research and development, in progress for many years before Pearl Harbor, made possible these accomplishments and contributed greatly to the total production of toluene, and the tremendous quantities of finished 100-octane aviation gasoline required by our Armed Forces.

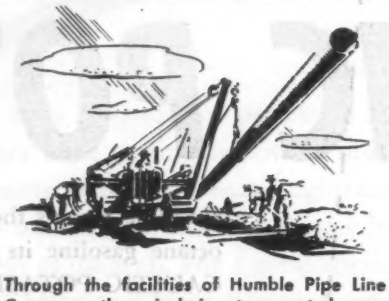


Baytown Ordnance Works, first synthetic toluene plant in the world, has supplied toluene for at least one out of every two bombs used by the United Nations since Pearl Harbor. For this production feat, Baytown Ordnance Works has five times been awarded the Army-Navy "E".

Baytown Refinery has made one billion gallons of finished 100-octane aviation gasoline —more than has been produced by any other plant in the world. The world's first commercial alkylation plant was built at Baytown in 1938. The alkylation process is the very backbone of 100-octane aviation gasoline production by the entire petroleum industry.



Humble Oil & Refining Company is the nation's largest producer of crude oil, and is currently supplying about one-fourth of the increased production required for war, as measured by the gain since 1941.



Through the facilities of Humble Pipe Line Company, there is being transported more oil than is being carried by any other system in the country. Nearly 700,000 barrels move daily through Humble pipe lines—one-seventh of all the oil production in the United States.

United in a great singleness of purpose, 14,000 Humble men and women are devoting themselves to the task of providing vital petroleum products for war, looking to the day when their 3,000 fellow employees and all their comrades in arms will return.

OPEN HOUSE AT BAYTOWN REFINERY, DECEMBER 14–17

So that one of America's great war plants may be seen in action, Baytown Refinery is holding open house from Thursday, December 14, through Sunday, December 17. The story of the refinery at war will be told by dramatic exhibits of petroleum war products and a great Army and Navy show of war machines and materials. Specially conducted tours will take Humble's friends and neighbors into the heart of the refinery itself.

HUMBLE OIL & REFINING COMPANY

HOUSTON, TEXAS HUMBLE

FOR DEPENDABLE VALVE SERVICE

Kennedy Flanged O.S.&Y. Iron Body Gate Valve for 800-lb. Water, Oil, or Gas Pressure

Two generations of engineers who have used Kennedy Valves know that they are thoroughly reliable in every respect. Every Kennedy Valve type can be depended upon to close tight, open easily, and give lastingly good service with minimum attention and maintenance expense. You are safe when you standardize on Kennedy. 240-page catalog sent on request.

THE KENNEDY VALVE MFG. CO.

Elmira, New York

Kennedy Products inciude Bronze and Iron Body Gate, Globe, Angle and Check Valves in all standard types and sizes; Malleable Iron and Bronze Screwed Pipe Fittings; Standard Cast Iron Flanged Fittings and Flanges; also 250-lb., 400-lb., 500-lb., and 800-lb. Iron Body Double Disc Gate Valves specially designed for Oil and Gas Industry Service.

KENNEDY *valves . . . pipe fittings . . . fire hydrants*

"TUBE-UP" for full efficiency

replace 'critical metal' substitutes

LUMMUS REFINERY EQUIPMENT

HEAT EXCHANGERS
•
CONDENSERS
•
REBOILERS
•
STEAM GENERATORS
•
STEAM JET REFRIGERATION
•
STEAM SURFACE CONDENSERS
•
BAROMETRIC CONDENSERS
•
STEAM JET AIR EJECTORS
•
EVAPORATORS

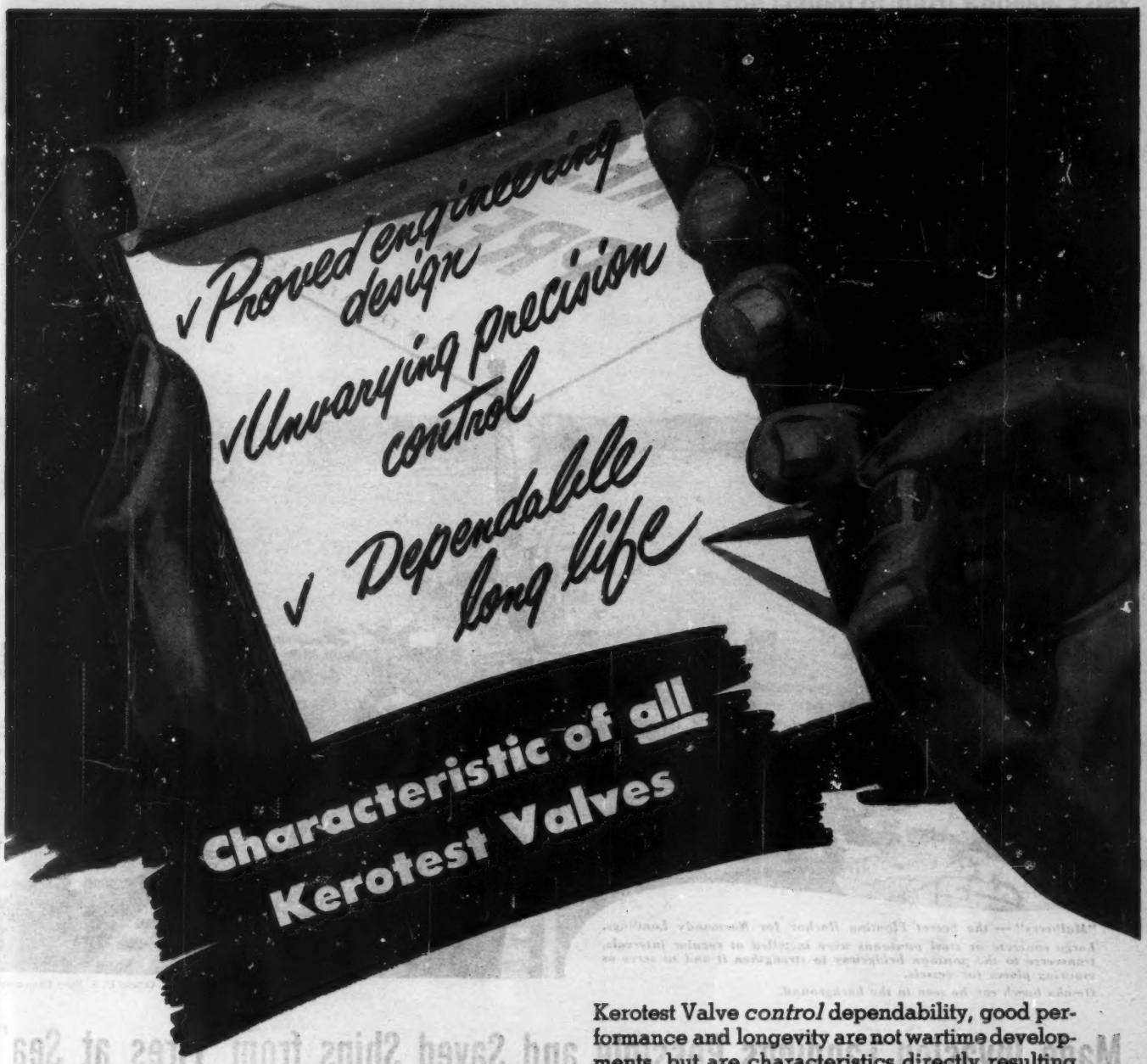
Lummus heat exchangers — purchased for war emergency oil refinery use during critical metal shortages — should now be reviewed for full heat transfer efficiency. In many instances tube bundles of substitute materials may now be replaced with bundles fabricated of metals that will increase operating performance. Furthermore, now is the opportune time to install additional heat exchangers which were necessarily omitted from plant design due to wartime restrictions.

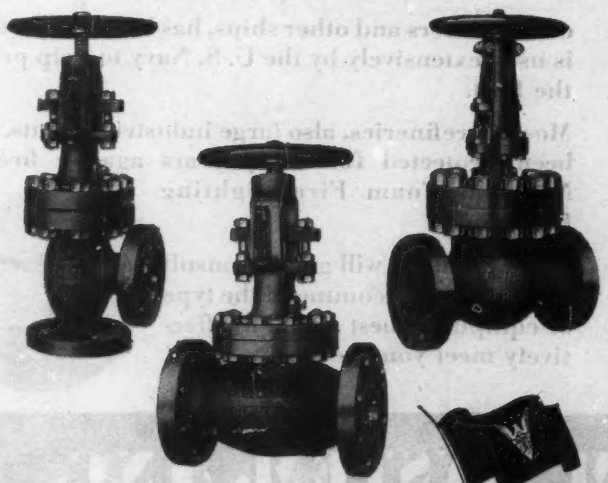
Lummus engineering service is available for making such a review and for the study of specific metal replacement problems and the modernization of oil refineries to meet post war requirements. For further information write to:

THE LUMMUS COMPANY · 420 LEXINGTON AVE., NEW YORK 17, N.Y.

LUMMUS

HEAT EXCHANGERS





Kerotest Valve *control* dependability, good performance and longevity are not wartime developments, but are characteristics directly resulting from more than *three decades* of intimate experience in solving difficult, industrial valve requirements. Our success in maintaining this reputation for high quality and maximum dependability while producing valves for war—in tremendous quantities—has developed new materials, new economies in production methods and new simplified designs. KEROTEST engineers are ready to apply these benefits to your present valve requirements—phone, wire or write your specifications for quotations or descriptive technical information.

KEROTEST MANUFACTURING CO.

PITTSBURGH, PA.

VALVES • FITTINGS • ACCESSORIES

"Mulberry" — the Secret Floating Harbor for Normandy Landings. Large concrete or steel pontoons were installed at regular intervals, transverse to the pontoon bridgeway to strengthen it and to serve as mooring places for vessels. Omaha beach can be seen in the background.

Official U. S. Navy Photograph

Made Invasion Landings Possible and Saved Ships from "Fires at Sea"

The U. S. Army and Navy, keenly aware of the difficulty of landing critical supplies to support the D-Day Invasion, cleverly conceived "Mulberry"—the Secret Floating Harbor—which was successfully anchored off Normandy Coast.

The U. S. Navy, always alert to protect the fleet and the crews who man it, was early to recognize the increased danger from fires at sea in modern warfare. National Foam, having many times demonstrated its efficiency in quickly extinguishing serious fires on oil tankers and other ships, has been adopted and is used extensively by the U. S. Navy to help protect the fleet.

Most oil refineries, also large industrial plants, have been protected for many years against fires by National Foam Fire Fighting Equipment.

Our Engineers will gladly consult with you and recommend the type of equipment best suited to effectively meet your needs.

NATIONAL FOAM SYSTEM, INC.

Specializing in Foam Fire Protection

Packard Building, Philadelphia 2, Pa.

TOOL STEELS

Midvale tool steels come from the school of hard knocks. They are the outcome of shop experience in making our own tools for some of the toughest machining jobs in all industry. The No. 1 Lesson is right steel. To get it in each case, we piled research on research, test on test. Result is a full Midvale line of modern tool steels, available for ready delivery on priority orders.

THE MIDVALE COMPANY • NICETOWN • PHILADELPHIA

OFFICES: NEW YORK • CHICAGO • PITTSBURGH
WASHINGTON • CLEVELAND • SAN FRANCISCO

MIDVALE

Custom Steel Makers to Industry

PAGE *Welding* ELECTRODES

NEW!

for AC or DC

Here's the newest member of the **PAGE** Electrode family. It is a general-purpose electrode, especially designed for welding light-gage mild steel in flat, vertical, overhead and horizontal positions with either alternating or direct current. The **PAGE HI-TENSILE AF ELECTRODE** produces an exceptionally smooth and uniform bead, slightly convex. This makes it most satisfactory for fillet and lap welds. For further details about this new electrode, get in touch with your **PAGE** distributor.

PAGE STEEL AND WIRE DIVISION
Monessen, Pa., Atlanta, Chicago, Denver, Los Angeles, New York, Pittsburgh, Portland, San Francisco

AMERICAN CHAIN & CABLE COMPANY, Inc.
BRIDGEPORT • CONNECTICUT

ESSENTIAL PRODUCTS • TRU-LAY Aircraft, Automotive, and Industrial Controls • TRU-LOC Aircraft Terminals • AMERICAN CABLE Wire Rope • TRU-STOP Brakes • AMERICAN Chain • WEED Tire Chains • ACCO Malleable Castings • CAMPBELL Cutting Machines • FORD Hoists, Trolleys • HAZARD Wire Rope • MANLEY Auto Service Equipment • MARYLAND Bolts and Nuts • OWEN Springs • PAGE Fence, Shaped Wire, Welding Wire • READING-PRATT & CADY Valves • READING Steel Castings • WRIGHT Hoists, Cranes • WILSON "Rockwell" Hardness Testers

In Business for Your Safety

SPLASH PROOF

TOTALLY ENCLOSED

PROTECTED MOTORS

When you must use motors under adverse operating conditions, select one of Master's Protected Type Motors.

They are available in sizes from 1/6 to 75 HP in a wide variety of electrical and mechanical modifications.

Investigate MASTER'S usual ability to serve you economically with motors that really fit your exact needs.

THE MASTER ELECTRIC COMPANY • DAYTON, OHIO

EXPLOSION PROOF

FAN COOLED

Men
Methods
Materials
Formula for a Gourmet's Dish
A master chef with kingly taste and the touch of an artist . . . a great recipe brought to perfection through years of trial-and-error . . . Ingredients that are flavorful and fresh. All this, *men, methods* and *materials* create great cooking.

You get insulation efficiency the same way

● All the elements *properly coordinated*—men, methods and materials. This is the RUBEROID way to assure maximum service from industrial insulation.

MEN . . . The right men are all-important. Skilled mechanics in the nationwide organization of Ruberoid Approved Applicators handle the jobs. These men know their business. They've licked the most difficult insulation problems.

METHODS . . . Each installation is "tailor-made" to meet the individual job. Ruberoid engineers are not wedded to any one method. You get the benefit of broad experience with all possible methods of application.

MATERIALS . . . The right insulation material to meet your specific temperature control problem. The Ruberoid insulation line has no "gaps" in it from 0° to 1900° F.

RUBEROID
INSULATION
A complete service

Write for Ruberoid Insulation Guide and technical data.
The RUBEROID Co., *Executive Offices*, 500 Fifth Avenue, New York 18, N.Y.
ASPHALT AND ASBESTOS BUILDING MATERIALS

First in War, First in Peace—

There's always a POWELL Valve for every requirement of Industry.

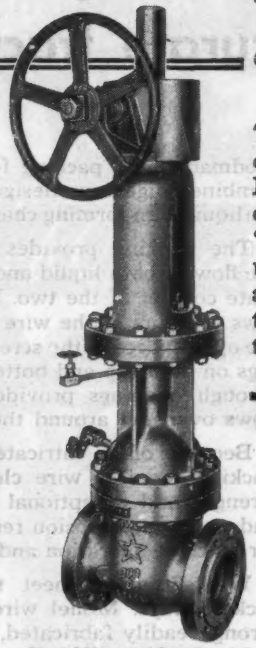
The "KNOW-HOW" acquired through 98 years of making valves—and valves only—has enabled POWELL Engineering to design valves to meet every problem of wartime flow control. This same "KNOW-HOW" is your assurance for the *post-war* future. Shown here are a few examples of a complete POWELL Line especially adapted to your industry. As new requirements arise, there'll be POWELL Valves to meet them.

The Wm. Powell Company

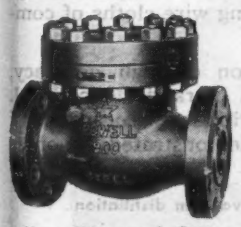
Dependable Valves Since 1846

Cincinnati 22, Ohio

Class 300-pound Cast Steel Motor Operated Gate Valve, venturied from 12" port size to 20" size end flanges.

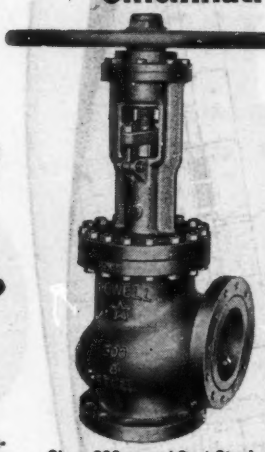


Class 300-pound Cast Steel, Bevel Gear Operated Gate Valve designed for ultra high temperature service.



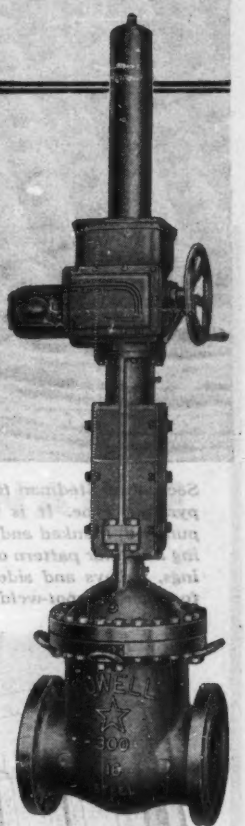
Class 900-pound Cast Steel Swing Check Valve.

300-pound Stainless Alloy (Hastelloy) Separable Body Reversible Seat "Y" Valve.

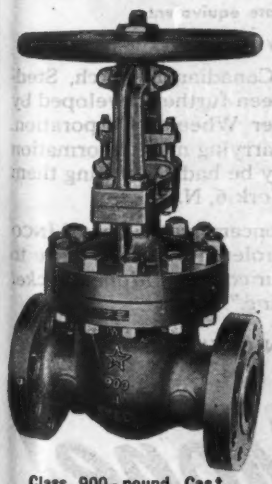


Class 300-pound Cast Steel O. S. & Y. Angle Valve for temperatures up to 1400 F.

125-150-pound Iron Body Bronze Mounted or All Iron "Master Pilot" Gate Valve.

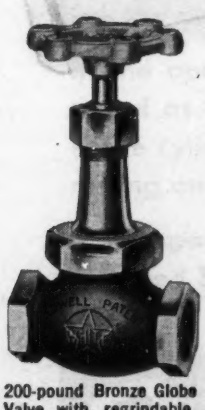


Class 300-pound 16" Cast Steel Gate Valve with top-mounted electric motor operator.



Class 900-pound Cast Steel O. S. & Y. Gate Valve.

150-pound Iron Body Bronze Mounted Globe Valve.



200-pound Bronze Globe Valve with regrindable, renewable seat and disc.

200-pound Bronze Gate Valve with renewable disc.

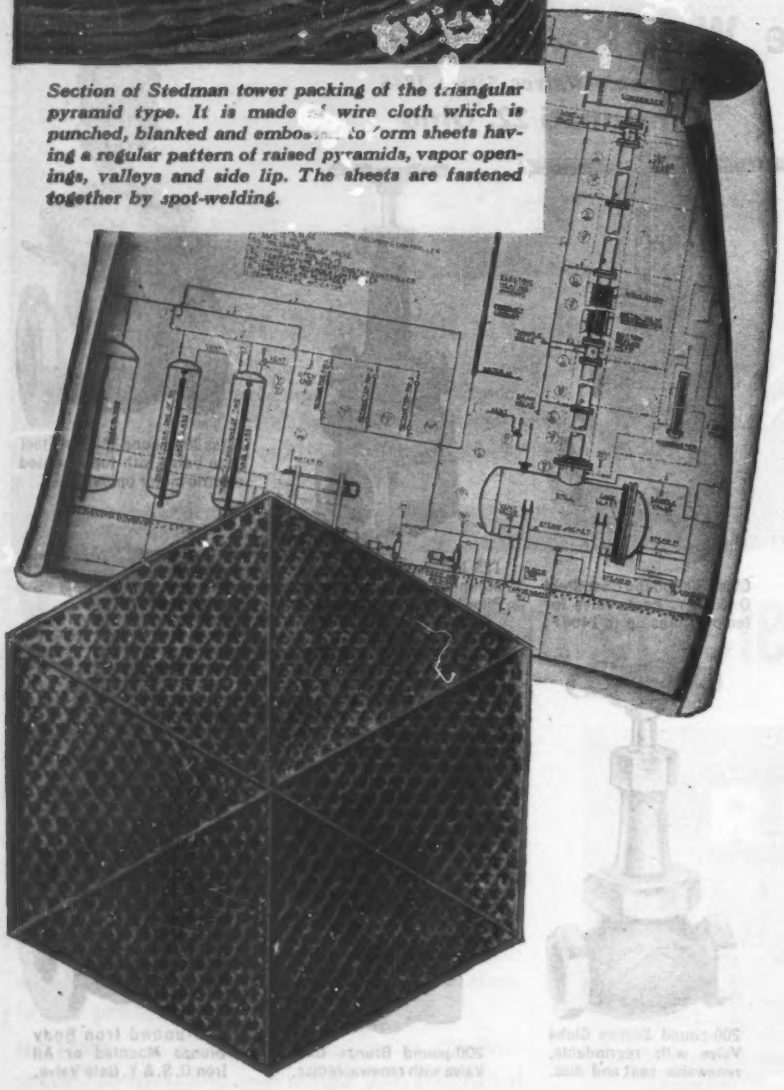
125-pound Iron Body Bronze Mounted or All Iron O. S. & Y. Gate Valve.

POWELL VALVES

WIRE CLOTH TOWER PACKING

...and how it helps to achieve more accurate fractionation

Section of Stedman tower packing of the triangular pyramid type. It is made of wire cloth which is punched, blanked and embossed to form sheets having a regular pattern of raised pyramids, vapor openings, valleys and side lip. The sheets are fastened together by spot-welding.



Arrangement of triangular Stedman packing sections in hexagonal casing as used in larger distillation units. The wire most commonly employed for cloth is 0.009" in diameter, and is woven into a 60 x 40 mesh. Illustrations supplied by Foster Wheeler Corp. For further information, see text.

Stedman tower packing for distillation processes combines ingenious design and construction with the liquid film-forming characteristics of wire cloth.

The packing provides independent paths for the flow of both liquid and vapor, yet assures intimate contact of the two. Liquid continuously follows contours of the wire cloth, forms a film over the open spaces of the screen, and seals mesh openings on both top and bottom surfaces. Vapor rises through openings provided in the packing, and flows over and around these surfaces.

Because of its intricate construction, Stedman packing requires wire cloth of high mechanical strength and exceptional amenability to forming and welding. Corrosion resistance, too, is essential for efficient operation and long life.

Well fitted to meet those specifications are nickel alloys. Monel wire cloth, for example, is strong, readily fabricated, and resistant to a wide range of corrosives. It has the additional advantage of being lowest in cost among wire cloths of comparable qualities.

In achieving fractionation of high accuracy, Stedman packing has been markedly successful. Its ability to separate individual hydrocarbons of 99%-plus purity has been demonstrated. Its other advantages include:

1. **Low frictional loss, vital in vacuum distillation**
2. **Low hold-up**
3. **Increased efficiency through reduction of installation height per theoretical plate equivalent**
4. **Increased yield of closely fractionated products**

Originally a product of Canadian research, Stedman tower packing has been further developed by the laboratories of Foster Wheeler Corporation. Their Bulletin ID-44-2, carrying more information on Stedman columns, may be had by writing them at 165 Broadway, New York 6, N. Y.

And for helpful data concerning the use of INCO Nickel Alloys in the petroleum industry, write to the address below for your copy of *"Monel, Nickel and Inconel in Oil Refining."*

THE INTERNATIONAL NICKEL COMPANY, INC.
67 Wall Street, New York 5, N. Y.

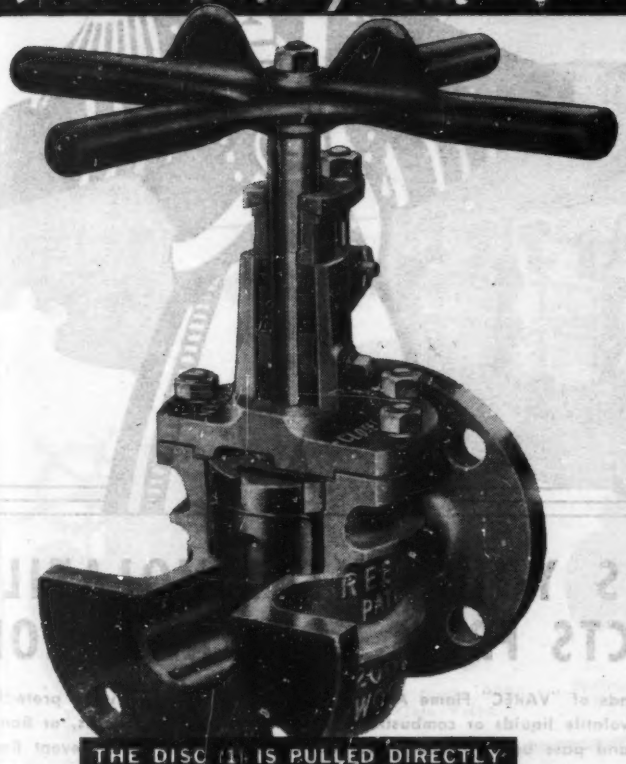
Monel

NICKEL INCO ALLOYS

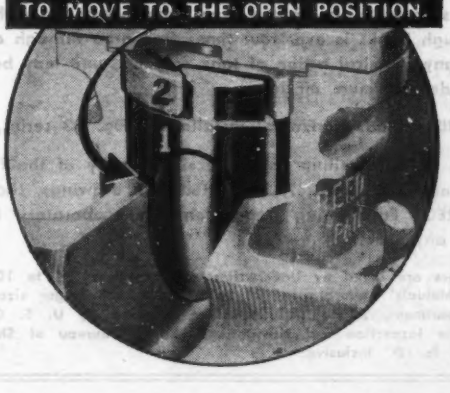
MONEL • "K" MONEL • "S" MONEL • "R" MONEL • "KR" MONEL • INCONEL • "Z" NICKEL • NICKEL • Sheet . . . Strip . . . Rod . . . Tubing . . . Wire . . . Castings . . . Welding Rods (Gas & Electric)

REED Quarter-turn Double Disc Gate VALVES

for Ease of Operation and Low Maintenance Costs



THE DISC (1) IS PULLED DIRECTLY AWAY FROM ITS SEAT, BY THE OPENING LUG (2) BEFORE IT STARTS TO MOVE TO THE OPEN POSITION.



FOR EASE OF OPERATION

THE SIMPLICITY OF CONSTRUCTION *means* LOW MAINTENANCE COSTS.

. . . and the exclusive Reed Valve Operating Principle Means Ease of Operation in Any Service.

Simplicity of construction means low maintenance costs—and the exclusive operating principle of Reed Valves assures ease of operation in any service.

Reed Valve discs are not subject to expansion or contraction of the valve body and fluid temperatures can vary widely without affecting the action of the valve.

In the open position the discs are fully protected as the trim material is applied to the entire cylindrical body bore and the discs are resting on trim material at all times.

It will pay you to investigate the merits of the Reed Steel Gate Valve.

Reed VALVE DIVISION
ROLLER BIT COMPANY
HOUSTON 1, TEXAS

THE PACE - SETTER SINCE 1928

THE FLAME ARRESTER THAT *Really* ARRESTS FLAME

GUARDS YOUR VITAL VOLATILE PRODUCTS FROM CONFLAGRATION

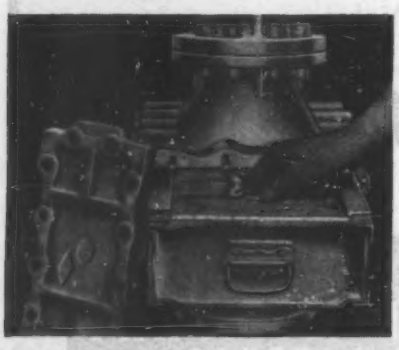
Tens of thousands of "VAREC" Flame Arrester installations assure genuine protection to vessels storing volatile liquids or combustible gases. Flame arresting Grids, or Banks, designed to trap and pass back to tank entrained molecular liquid and prevent flame propagation, are manufactured from noncorrosive sheet aluminum, brass or copper. Housings are cast aluminum, semisteel or steel. Scientifically engineered, streamlined housings and expanding passageways guarantee free tank breathing with minimum pressure drop. Free area through Banks is over four times free area through corresponding pipe size. To counteract any chemical action of tank contents, unit may be furnished in various materials to provide maximum efficiency.

Vertical Fig. 50 series is illustrated. Horizontal installation, Fig. 53 series, available.

May we place your name on our mailing list to receive a copy of the forthcoming "VAREC" Catalog and Handbook P-7, profusely illustrated with drawings, charts, engineering data, etc. The "VAREC" Engineering Department and Laboratory is at your command for consultation at any time.

"VAREC" approved Flame Arresters are listed by Underwriters' Laboratories, 2" to 10" inclusive, approved by Associated Factory Mutuals' Laboratories, 2" to 6" inclusive (larger sizes pending), approved by U. S. Treasury Department, 2" to 10" inclusive, approved by U. S. Coast Guard (formerly U. S. Bureau of Marine Inspection and Navigation), Lloyds' Bureau of Shipping, and American Bureau of Shipping, 2" to 10" inclusive.

Section of "VAREC" Flame Arrester Grid



The FIRST, most Simple and Fool Proof Extensible Arrester Bank. Illustrating ease of inspection and maintenance.

THE VAPOR RECOVERY SYSTEMS COMPANY

Consultants, Designers, Manufacturers of Gas Control and Tank Equipment.

COMPTON, CALIFORNIA

Branch Offices and Stocks Carried at

New York City — Tulsa, Okla. — Houston, Texas — New Orleans, La.

Agencies Everywhere •

PROTECT WITH "VAREC"

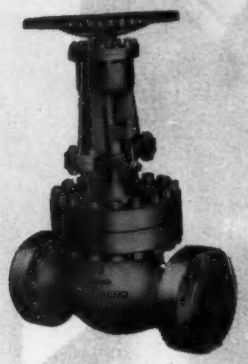
Backed by MORE THAN A CENTURY OF VALVE "know-how"

WALWORTH CAST STEEL VALVES

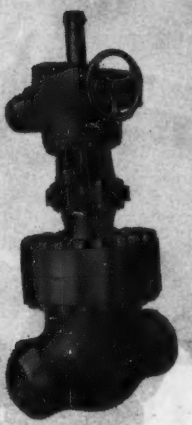
Walworth Steel, Ball-Bearing Type Lubricated Plug Valve

Walworth Series 300 Steel Gate Valve

Walworth Series 600 Steel Globe Valve



Walworth Series 1500 Steel Gate Valve



Walworth Series 1500 Motor-operated Steel Gate Valve with Welding ends.

Since 1842, Walworth has continuously manufactured valves and fittings for every piping requirement. This unmatched background of experience in valve design and manufacture has given Walworth valves their outstanding reputation for dependability, economy, and long service life.

Walworth Cast Steel Valves — made in a complete line of types and sizes — are excellent modern examples of Walworth valve leadership. They combine the latest features of advanced valve design with the traditional manufacturing skill which has made Walworth valves famous throughout the world.

See your Walworth distributor for further information on Walworth steel valves, or write for a free copy of Catalog 42. It describes Walworth's complete line of valves and fittings in steel, bronze, and iron.

ARMY E NAVY

11 AWARDS TO 4 PLANTS

WALWORTH

valves AND fittings

60 EAST 42nd STREET, NEW YORK 17, N. Y.

WALWORTH ★ VALVES AND FITTINGS ★ ESTABLISHED 1842

DISTRIBUTORS IN PRINCIPAL CENTERS THROUGHOUT THE WORLD

WOLVERINE

LOOKS *First*

EXTRUDES *After*

The casting flaws that may be concealed underneath the skin of condenser tube billets do not get a chance to go very far here at Wolverine. They are caught "in the bud". Immediately after being cast, each billet is scalped; that is, it has its outer surface shaved off revealing a bright surface which permits easier spotting of even the tiniest flaws.

That is the only sure way of detecting casting imperfections which sometimes occur just beneath the surface. The only way to know what is hidden under the outside surface is to take it off and look.

That's another reason why you can always be sure of high quality in Wolverine Condenser Tubes.

BUY WAR BONDS

Wolverine

TUBE DIVISION

CALUMET & HECLA CONSOLIDATED COPPER COMPANY

Vinson SUPPLY COMPANY

Service That COVERS the Mid-Continent

FISHER
Automatic Controllers

CHASE
"Antimonial Admiralty" CONDENSER TUBES
Standard Brass Products

NATIONAL
Pipe and Steel Tubes

Supply Headquarters for the Refiner

VINSON SUPPLY CO

and Natural Gasoline Manufacturer

TULSA
DALLAS • AMARILLO • ODESSA

FACILITIES TO DO THE JOB!

Manufacturers and fabricators of all types of welded sheet and steel plate products. Facilities to do the job whether large or small. Engineering skill backed by constant research.

All equipment is designed, manufactured and supervised by men who have had many years experience in steel plate construction.

TANKS BY BANKS

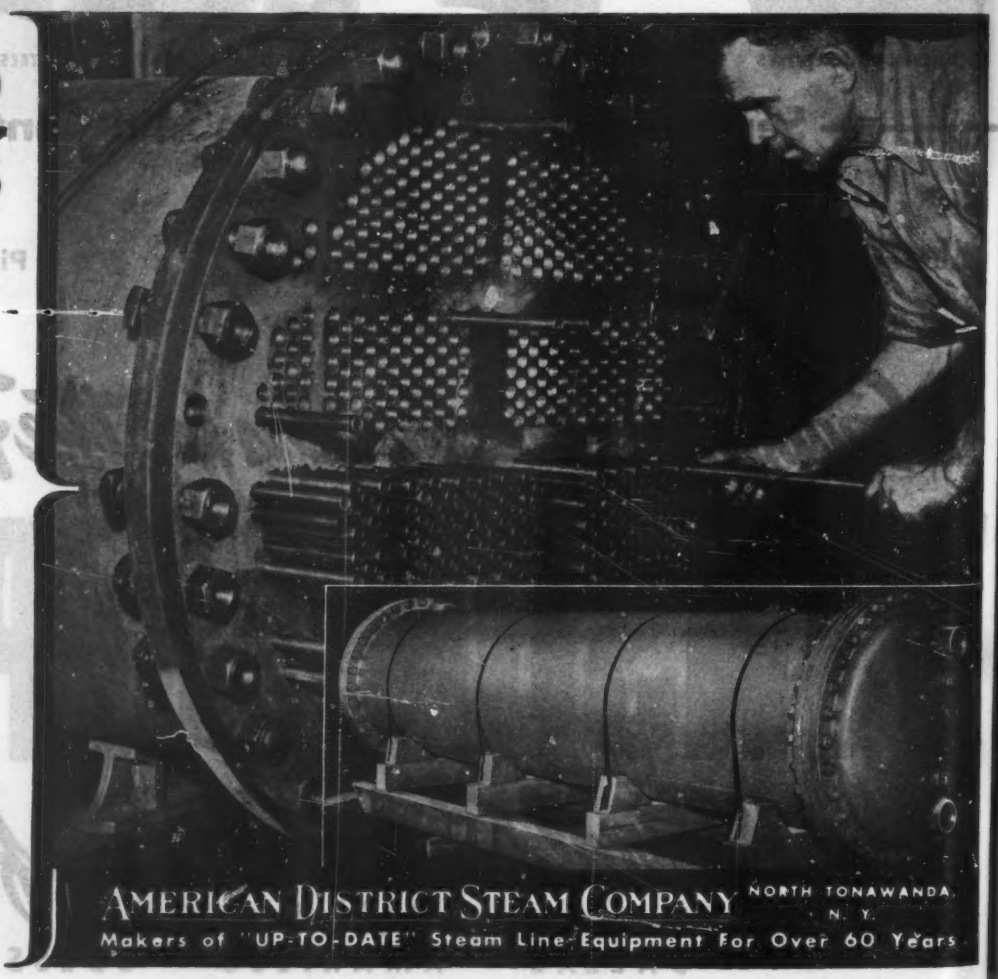
DALLAS TANK Company, Inc.

201-5 W. COMMERCE ST., P. O. BOX 5387, DALLAS, TEXAS

ADSCO HEATERS are BUILT TO YOUR ORDER

. . . and what is equally important, ADSCO has built heaters for dozens of different applications —can design and build a heater that has the capacity, efficiency and reserve requirements exactly suited to your particular operating conditions.

Whether you require horizontal or vertical, storage or instantaneous equipment to heat or cool water, gases, oil or other liquids, write us or send for Bulletin 35-75R.



AMERICAN DISTRICT STEAM COMPANY NORTH TONAWANDA, N. Y.

Makers of "UP-TO-DATE" Steam Line Equipment For Over 60 Years

ON A SILENT NIGHT...

To see the lights coming on again in a war-darkened world holds a special thrill for those whose skill and sweat made what was needed to win the Victory . . . To all of the workers in American industry, we at GATX wish at this holiday season a full measure of the American blessings they have so richly earned.

GENERAL AMERICAN TRANSPORTATION CORPORATION

GATX GENERAL AMERICAN PLATE & WELDING DIVISION PLANT AT SHARON, PA.

Plate & Welding Division — Sharon, Pennsylvania

Specialists in plate fabrication—manufacturers of pressure vessels of steel, alloys and aluminum—all classes of welding—process equipment of all types—chemical engineering laboratories and service—completely equipped field erection department.

Send for it Now!

YOU'LL WANT
IT IN YOUR FILE

LILIE-HOFFMANN COOLING TOWERS
INCORPORATED

NEW CATALOG

Just off the Press

FURNISHES YOU FACTS OF COOLING TOWER DESIGN, ENGINEERING, CONSTRUCTION AND PERFORMANCE

MAIL COUPON TODAY

LILIE-HOFFMANN COOLING TOWERS, Inc.
4239 Duncan Ave., St. Louis 10, Mo.
Mail catalog to:

*Name*_____
*Position*_____
*Co. Name*_____
*Street and No.*_____
*City*_____ *State*_____

This
"SNAPPING" DISC

ON STEAM USING UNITS

This cut-away view shows the Snap Action Thermal Air Eliminator located on the inverted bucket.

● For instant heat in steam using units, use ANDERSON SUPER SILVERTOP STEAM TRAPS with a Thermal Air Eliminator. This Eliminator is a thermostatic disc on the side of the bucket covering small air ports. When cold, the disc is convex and ports open . . . Steam instantly forces air out of the ports and the heat "snaps" the disc closed, preventing steam loss. With air removed the unit fills instantly with hot, dry steam. Thus the "Snapping Disc" saves time and fuel necessary for a warming-up period. The free book, "How to Choose a Steam Trap," gives complete details.

THE V. D. ANDERSON COMPANY
1942 West 96th Street • Cleveland 2, Ohio

Super-Silvertop
STEAM TRAPS

WITH PRESSTITE
SEALING and COATING COMPOUNDS

Bolted Tank sealing compounds developed by Presstite are now being used by the United States Army and Navy for sealing gasoline storage tanks all over the world. These compounds are now available to the oil industry.

Presstite offers plastic compounds and cements, all highly resistant to the action of aromatic gasoline, oil, water, etc., plus oil and gasoline resistant coatings to prevent corrosion on the inside of storage tanks.

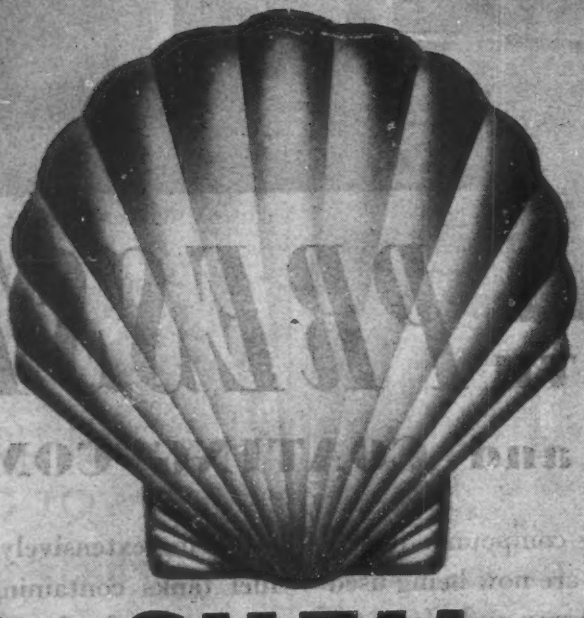
Many Presstite sealing compounds are being extensively used to seal aircraft fuel tanks containing high octane fuels; others seal fuselage seams in pressurized cabins and other vital parts. Due to the demands of War, Presstite has successfully solved some of the toughest sealing jobs ever presented.

Presstite sealers and coatings may well solve your problems, too, provide longer tank life and prevent loss through leakage in a variety of applications. Our sealing specialists will gladly work with you and your engineers—just write or send us detailed information on your requirements.

PRESSTITE
SEALING COMPOUNDS

PRESSTITE ENGINEERING COMPANY · 3974 Chouteau Avenue, St. Louis 10, Missouri

PENTANE ISOMERIZATION



another **SHELL** *first!*

Again Shell has shared the results of its research by signing the first license for the production by isomerization of

ISOPENTANE

—the volatile high-octane component of the "Fuels of the Future."

Do you need Isopentane? Wire or write us at
50 West 50th Street, New York 20, New York

SHELL DEVELOPMENT COMPANY

Why REPUBLIC ENDURO USUALLY COSTS LESS PER YEAR OF SERVICE . . . .

Republic ENDURO Stainless Steel may cost more than less resistant materials—but remember this: *It usually costs less per year of service life.*

ENDURO is highly resistant to rust and corrosion. It may be used efficiently and economically with most acids and alkalies, either hot or cold. It does not contaminate substances which come in contact with it.

ENDURO resists scaling and oxidation at high temperatures, too. Its high creep strength insures safety when used for load-bearing equipment which must operate hot.

And ENDURO is resistant to abrasion and rough use. It is strong and tough enough to take punishment.

Because of these qualities, equipment made of ENDURO requires less attention and less maintenance. Equipment life is extended. The cost per year of service drops substantially. And available operating time is increased.

This cost-cutting metal has proved its economy in tower linings, as shown above—in valves, tubes, pressure vessels and similar applications in the petroleum and other industries where chemical processing is the principal operation.

ENDURO is employed by many equipment manufacturers in their products. It can be fabricated to your specifications in the construction of special equipment. Send us your questions on the use of this material. You'll get your answers —promptly.

REPUBLIC STEEL CORPORATION

Alloy Steel Division • Massillon, Ohio

GENERAL OFFICES • CLEVELAND 1, OHIO

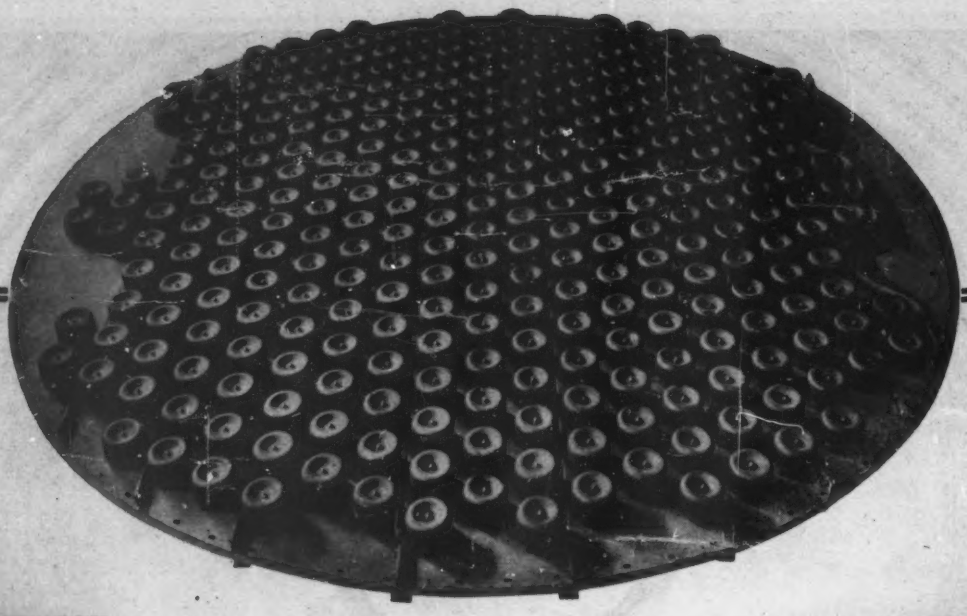
Berger Manufacturing Division • Culvert Division
Niles Steel Products Division • Steel and Tubes Division
Union Drawn Steel Division • Truscon Steel Company
Export Department: Chrysler Bldg., New York 17, N. Y.

Republic

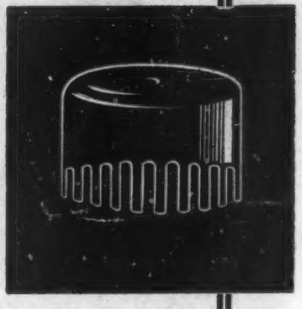
ENDURO STAINLESS STEEL

Reg. U. S. Pat. Off.

Other Republic Products include Carbon and Al



They're Everywhere



Oil refiners everywhere specify P. S., for Pressed Steel Company, Bubble Caps, Trays and Risers. They have good reasons, for P. S. refining equipment is made of **special** alloy steel plus years of experience in manufacture.

P. S. Bubble Caps, Trays and Risers weigh 75% less than cast iron equipment, thereby providing sizable savings in haulage, repair and replacement . . . while they reduce weight on the tower thus permitting lighter, less costly structures. They "coke up" less rapidly; they do not break nor wear out quickly for they are heat treated **after** fabrication.

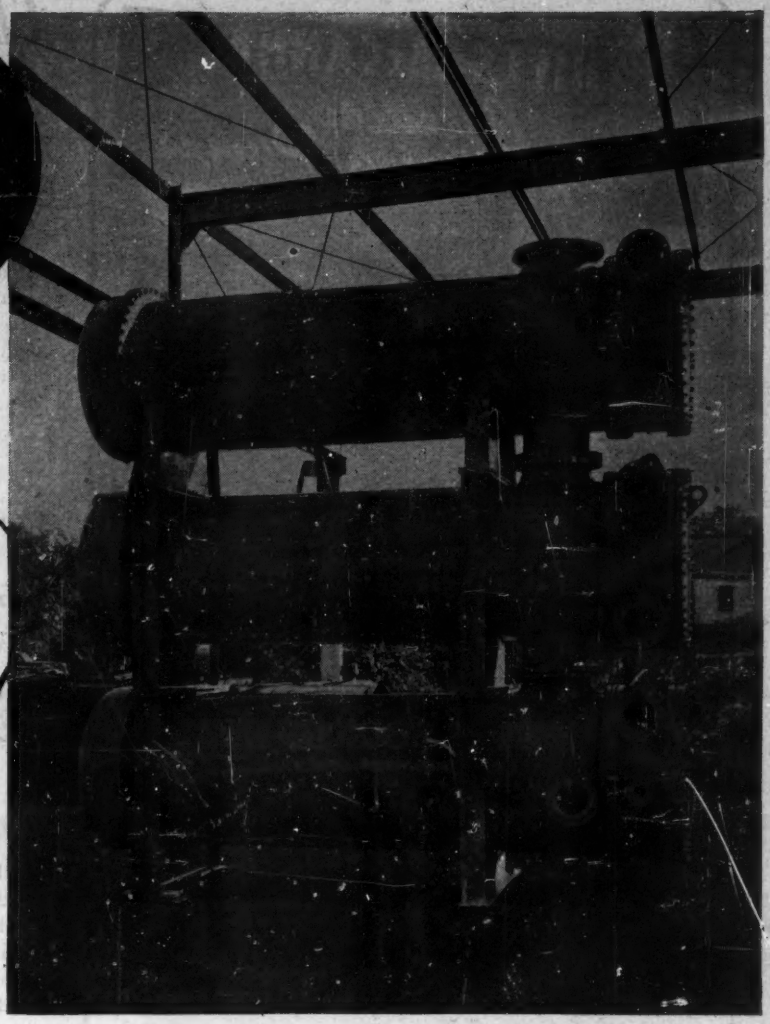
THE PRESSED STEEL COMPANY

of WILKES-BARRE, PENNSYLVANIA

BRANCH OFFICES: 312 Curtis Bldg., Detroit; 606 Nicholas Bldg., Toledo; 1915 Engineers Bldg., Chicago; 54 E. 42nd St., New York; 1005 Sterling Bldg., Houston, Texas; A & M Accessories Ltd., 19 Melinda St., Toronto, Canada; Broad St. Station Bldg., Philadelphia

PRESSED STEEL COMPANY PRODUCTS: Carburizing and Annealing Boxes, Thermocouple Protection Tubes, Seamless Steel Cylinder Caps, Seamless Steel Neck Rings, Welded Alloy Tubing for High Temperature and Corrosive Applications, Radiant Tubes, Inner Covers and Base Sheaths for Steel Mills

Typifying
PATTERSON-KELLEY
Service and Products



HEAT EXCHANGERS

designed and built to meet the needs of the refinery

Knowledge of two broad subjects is brought to focus on the heat exchangers we design and build for refineries. Our engineers are thoroughly familiar with refinery operations, with the problems of heat transfer, and with the behavior of petroleum products during such action. Our shopmen have years of experience in constructing heat exchangers, and have worked with all the commercially used metals. Our shop is well equipped and modern in every respect.

That's an assuring combination of knowledge and experience. It assures you of (1) intelligent cooperation with your engineers if you prefer to design your own exchangers; (2) ability to do the designing for you; and (3) properly constructed units.

EST. 1900

THE PATTERSON-KELLEY Company, Inc.

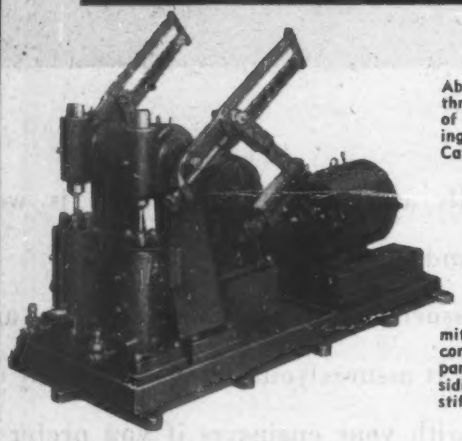
Main Office and Factory **113 WARREN STREET, EAST STROUDSBURG, PA.**

BOSTON 16, 96-A Huntington Avenue • NEW YORK 17, 101 Park Avenue • PHILADELPHIA 3, 1700 Walnut Street • CHICAGO 4, Railway Exchange Building

Representatives in All Principal Cities

HILLS-McCANNA Chemical Proportioning Pumps

...on the job at the Cities Service 100 Octane Gasoline Plant, Lake Charles, Louisiana



Above photo shows three, of a shipment of eight pumps, feeding Oil Silica Base Catalyst in control room. The 3 pumps shown have jacketed bodies which permit circulating a heating or cooling medium through the jacketed section. This construction permits the handling of constituents such as paraffin, phenol, residium tar, asphalt, stiff emulsions, etc.

We're intensely proud of the many diversified applications of Hills-McCanna Proportioning Pumps in the Petroleum Industry. They're the key to countless pumping jobs where accuracy of feed, dependability, and corrosion resistance are required.

Available in a series of types and sizes to suit any proportioning requirement. Capacity range to 1800 G.P.H. Pressure range to 22,500 p.s.i. Write for details and suggestions.

HILLS-McCANNA CO.

2441 NELSON STREET, CHICAGO, 18

PROPORTIONING PUMPS • AIR & WATER VALVES • CHEMICAL VALVES
MARINE VALVES • FORCED-FEED LUBRICATORS • DOWMETAL CASTINGS

Check This List of Aluminum Chloride Use

There are so many hydrocarbon reactions in the petroleum field where Hooker Anhydrous Aluminum Chloride can play an important part that you may be overlooking an opportunity to profit from its use. Five common applications of Aluminum Chloride as a catalyst are indicated below. If you are using these processes or can use them, you will find Hooker Anhydrous Aluminum Chloride profitable to use. Improvements in our manufacturing process insure you of a highly uniform, dependable catalyst.

PRACTICAL APPLICATIONS

1. ALKYLATION or CONDENSATION	of paraffins with olefins to manufacture motor fuels. of aromatics with higher olefins or alkyl halides. to synthesize pour-point depressants for lubricating oils.
2. CRACKING	of high-boiling hydrocarbons to manufacture gasolines.
3. REFINING	by decomposition of organic sulfur compounds by polymerization of gum-forming constituents
4. POLYMERIZATION	of low-boiling hydrocarbons to manufacture motor fuels and lubricants.
5. ISOMERIZATION	to manufacture branched paraffins of high anti-knock value. to effect ring closure of aliphatic hydrocarbons. to confer increased aromaticity.

Although Anhydrous Aluminum Chloride is very widely used as a catalyst, another Hooker catalyst, Anhydrous Antimony Trichloride, is rapidly becoming of interest to some petroleum chemists. This Hooker product is widely used as a catalyst in other fields and is worth your investigation. Physical properties of these two Hooker Catalysts are given below.

PHYSICAL PROPERTIES

Aluminum Chloride, Anhydrous—$AlCl_3$

Molecular Wt.	133.3
Solubility Gms/100 gms	
Nitrobenzene	26.6 at 20°C
Orthochlornitrobenzene	22.6 at 20°C
Heat of solution	550 small calories/gram minimum
Description: Gray crystalline solid.	
Analysis: Aluminum Chloride	99% Min.
Iron	0.1% Max.

USES: As a catalyst for Friedel-Crafts reactions; polymerization, isomerization, halogenation in petroleum and rubber industry. Also used in dye making, photographic chemicals and pharmaceuticals.

Antimony Trichloride, Anhydrous—$SbCl_3$

Molecular Wt.	228.1
Melting Point °C	73.4
Solubility Gms/100 gms	
Benzene	30.5 at 20°C
Monochlorbenzene	56 at 20°C
Description: Yellowish solid.	
Analysis: Antimony Trichloride	99% Min.
Iron and Arsenic	1% Max.
Lead	0%

USES: As catalysts in manufacture of dyes and pharmaceuticals; intermediate in manufacture of antimony salts; a mordant in textile printing; moisture and fireproofing textiles.

Write for physical data on these two products and ask for a copy of Bulletin 100, the Ho General Products List. You are sure to find some chemicals to help you to profit by thei

Caustic Soda — **Sodium Sulfhydrate**
Chlorine — **Sulfur Dichloride**
Muriatic Acid — **Sodium Sulfide**

HOOKER ELECTROCHEMICAL CO.
Buffalo Ave. at 47th Street
Niagara Falls, N. Y.

New York, N. Y. — **Tacoma, Wash.**
Wilmington, Calif.

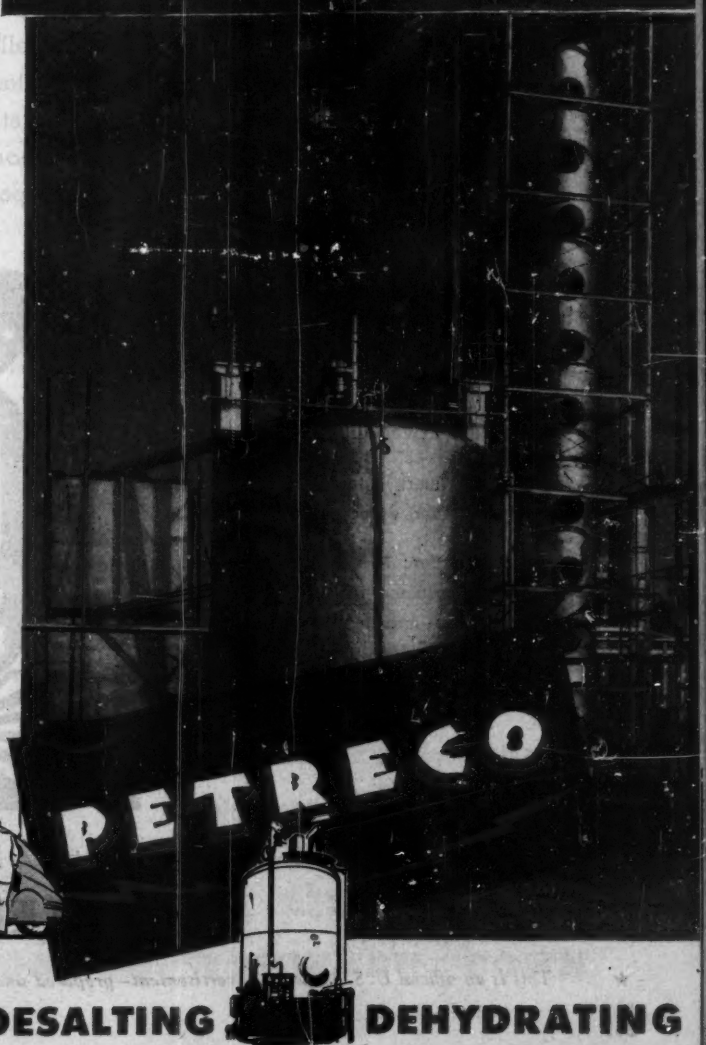
HOOKER CHEMICALS

PETRECO DESALTING INCREASES ON STREAM TIME 500%

FOR A MICHIGAN REFINER

A single Petreco Desalter in a Michigan refinery increased the onstream time from 10 to over 60 days . . a 500% increase in the length of runs. This gain in onstream time was only one of the benefits resulting from Petreco Desalting. Restoring capacities retarded by plugging and scaling, the topping throughout increased 500 barrels per day. This tremendous improvement due directly to Petreco desalting is indicative of what can be accomplished in increased plant capacity and efficiency wherever salty crudes are impeding operations and lowering quality.

The size of your refinery does not limit the benefits available to you from efficient desalting. Petreco Processing is in daily use in many refineries, both large and small. If you have a *salt problem,* a Petreco engineer will gladly discuss it with you.



PETROLEUM RECTIFYING COMPANY

5121 So. Wayside Drive, Houston 1, Texas
648 Edison Building, Toledo 4, Ohio
530 West Sixth Street, Los Angeles 14, Calif.

Representatives in principal production and refining centers

DESALTING DEHYDRATING

They're Going Overboard For Victory—Are YOU?

USE 8-POINT PLAN FOR AN OVERBOARD DRIVE IN THE 6th WAR LOAN!

NOV. 20th TO DEC. 16th

Our fighting men still have a long way to go! But—your plant-wide selling of the 6th can do much to shorten their embattled miles—lessen the price they so willingly pay for victory! Join the coast to coast parade of patriotic firms that are assuring an "overboard" showing in the 6th by following through on every point in the 8-Point Plan.

Start the ball rolling by appointing a **6th War Loan Bond Committee**, representing labor, management and other groups.

Carry on by selecting a **Team Captain**—preferably a returned veteran—for every 10 workers.

Right at the start, establish a **Quota** for each department—and every employee.

Arrange frequent **Meetings** of Captains, highlighting importance of their work—effective sales methods—and need for painstaking study of Treasury Booklet, Getting The Order.

Make definite **Assignments** to those best equipped to arrange music, speeches, rallies, competitive progress boards and meeting schedules.

Issue Individual Pledge Cards—made out in the name of each worker and providing for both cash and installment purchase.

Resolicit! This is the secret of "overboard" War Bond subscriptions. Your State Payroll Chairman has a special Resolicitation Plan for you to put into action near the end of the campaign.

Give generously of your **Advertising Space** to drive home the War Bond story.

The Treasury Department acknowledges with appreciation the publication of this message by

PETROLEUM REFINER

★ *This is an official U. S. Treasury advertisement—prepared under auspices of Treasury Department and War Advertising Council* ★

It's the Nash!

Nash Compressors in your plant can automatically increase the capacity of your absorption equipment, for with the Nash it is possible to secure absorption directly in the pump.

This is due to the Nash liquid compressant operating principle, involving a fluid vortex through which the gas must pass in the process of compression. To absorb from a gas, simply flow absorbent through the compressor as the compressing medium. In this close contact of liquid and gas, the desired fractions are picked up and retained by the absorbent. This in no way impairs efficiency as a compressor.

This useful stunt is made possible by the fact that slugs of liquid entering a Nash Compressor do no harm to the pump structure. Nash pumps have only one internal moving part, simple, non-wearing, and employ no gas contaminating internal lubrication. There are no valves, gears, pistons, or sliding vanes, and original pump efficiency is maintained over a long life. In a single stage Nash Compressors produce 75 lbs. pressure or vacuums to 26 in. of mercury, with capacities up to 6 million cubic feet per day in a single structure. Investigate these pumps now.

One moving part.
No internal wearing parts.
No valves, pistons, or sliding vanes.
No internal lubrication.
Low maintenance.
Slugs of liquid entering pump do no harm.
Original performance constant over a long pump life.
Non-pulsating pressure.
Saves floor space.
75 pounds in a single stage.

NASH ENGINEERING COMPANY
304 WILSON, SO. NORWALK, CONN.

MILTON Roy Step-Valve PUMPS

This is the Valve that Makes 'Em "Tick"

Milton Roy Pumps are the answer to *most* chemical and high-pressure pumping problems. They are handling successfully many viscous liquids, slurries, solids and fibres in suspension, and other materials which it is impossible or difficult or too costly to pump by other means. They are doing the more common-place jobs of pumping acids, alkalies, oils, solvents, etc., in exactly controlled volumes, at pressures up to 20 thousand pounds per sq. inch, more efficiently and more economically than is possible by other means. In hundreds of installations the advantages of the Milton Roy Step-Valve design have been proved, conclusively, in years of service. And what are these advantages?

- **Quick and easy accessibility of each individual ball-check *without disconnecting suction or discharge piping.***
- **Streamline flow of liquid through valve with resulting *self-cleaning action and minimum slippage.***
- **Double-ball checks . . . positive in action, even when working with liquids containing high percentages of solids in suspension. If one ball is held off its seat the second ball-check holds . . . thus eliminating "orifice action" under a partially closed valve and effectively *eliminating wire-drawing of the valve seat.***
- **Complete and immediate discharge of air or gas from the valve chamber . . . impossible to "pocket" air. With the Step-Valve pump, therefore, high and reproducible volumetric efficiencies are assured . . . *exactly the same volume of material is delivered at a given stroke setting with every stroke of the pump.***
- **The Milton Roy Step-Valve with single cover plate (illustrated) is particularly well adapted for handling VISCOUS MATERIALS, CRYSTALS IN SUSPENSION, FIBRES IN SUSPENSION, SLURRIES, FOOD PRODUCTS.**
- **Flow resistance in this type Step-Valve is at a minimum because the ball-checks *lift completely out* of the stream of flow . . . the flow passes *under the ball-checks, not around them.***
- **Removal of the single cover plate provides complete and quick accessibility . . . ball-checks and pump chamber may be thoroughly cleaned whenever required, as in handling foods for example.**

These are only a few of the principal advantages of Step-Valve design. Write for Bulletin 426 with the complete story. Ask also for the Milton Roy Pump Catalog if you do not have one in your files.

MILTON Roy PUMPS
1383 E. MERMAID AVE., CHESTNUT HILL, PHILA. 18, PA.

CROLL-REYNOLDS EVACTORS

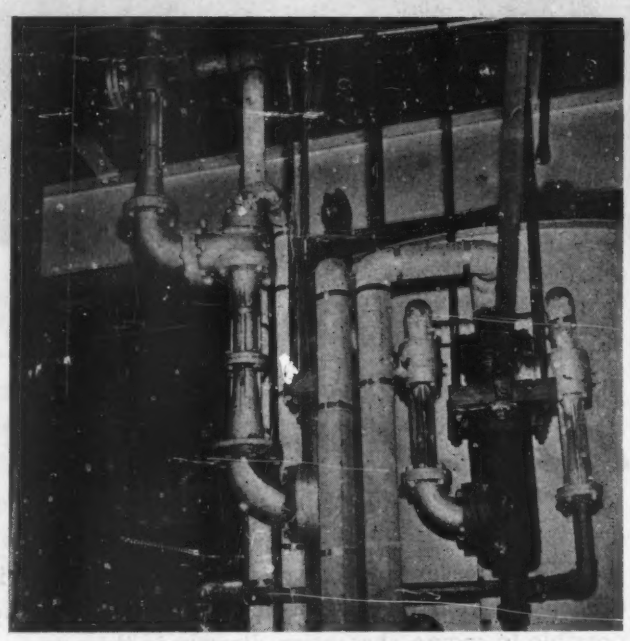
for

efficient

and

dependable

HIGH VACUUM



The above view shows an operating installation of a 4-stage Evactor serving a still handling a high boiling organic material at an absolute pressure of one tenth of 1 mm. In this plant, as in so many others using Croll-Reynolds Steam Jet Evactors, a duplicate installation was made when capacity had to be increased.

Evactors are available in single and multi-stage units of various types and are serving a wide variety of requirements in the petroleum and chemical industries, including vacuum refrigeration and vacuum cooled heat exchangers.

CROLL-REYNOLDS ENGINEERING CO.

17 JOHN STREET NEW YORK 7, N. Y.

CALAPOR

CAPTAIN PRODUCTS

Distributors of

K-LO INSULATING BLOCKS

A new development in a molded insulating block which provides exceptionally high efficiency coupled with unusual structural qualities and lightness in weight. Applicable to temperatures up to 1600 degrees. The K-Lo Insulating Block may be used as a structural medium and an insulation combined.

Available for immediate delivery from our Houston factory.

COMPANION PRODUCTS:

CALAPOR LONG FIBRE INSULATING AND FINISHING CEMENT the covering capacity of which is 46 sq. ft. 1 in. thick per 100 pounds.

CALSEAL FIBRATED EMULSION for weatherproofing. Fewer pounds give greater coverage.

Available for immediate delivery from our Houston factory.

CALAPOR MANUFACTURING CO.

Office: Hibernia Building, New Orleans, La.

Factory: 5521 Clinton Drive, Houston, Texas

75TH ANNIVERSARY

DEAN BROTHERS PUMPS INC. INDIANAPOLIS, INDEANA. PUMPING MACHINERY

1869 — 1944

ESTABLISHED 1869

DEAN BROTHERS PUMPS INC.

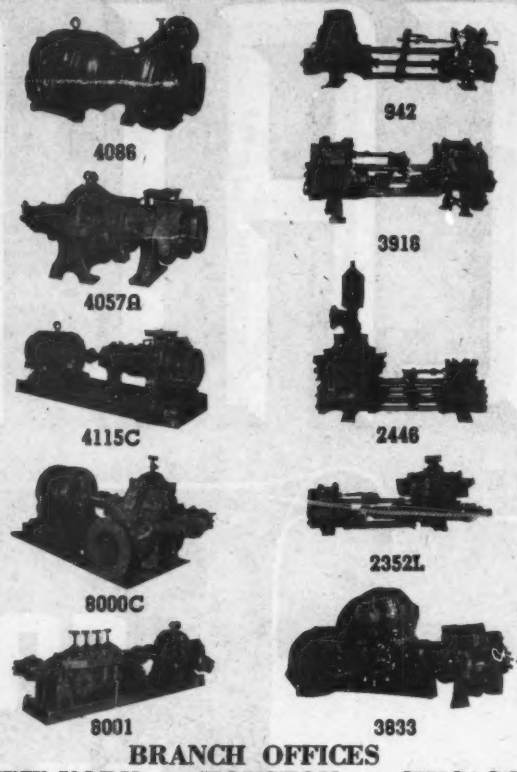
INDIANAPOLIS IND.

323 W TENTH ST.

PUMPS

RECIPROCATING

CENTRIFUGAL



BRANCH OFFICES

NEW YORK HOUSTON CHICAGO

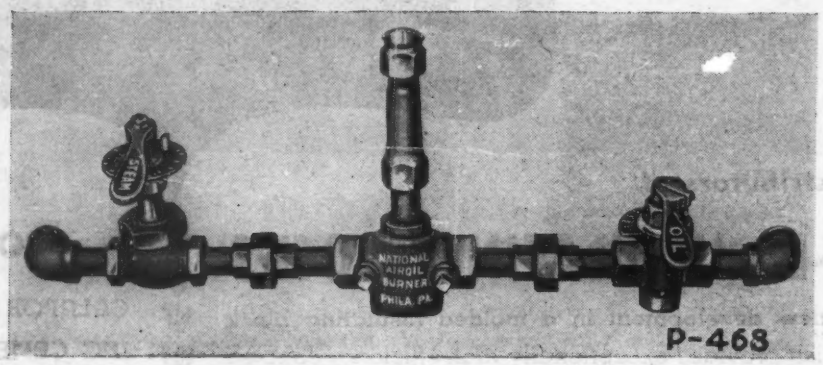
for . . .

VERTICAL FIRING

UPWARD ↑

OR

DOWNWARD ↓



P-468

NATIONAL AIROIL FUEL OIL - GAS BURNERS

The 32 years experience of the National Airoil Burner Company in the design and manufacture of oil and gas burners, naturally led to the development of entire combustion units for firing vertically, upward or downward. We have made successful numerous installations of this type, many of which are quite large, for firing Steam Superheaters, Petroleum Crude Oil and Cracking Heaters, Direct Fired Air Heaters, Chemical Retorts and Kilns.

In the illustration above we show the assembly of our special upfired S.A.R. Oil burner with oil (at right) and steam (at left) control valves.

Regardless of the size of the installation we can supply oil-gas burning equipment to meet your specifications . . . call on us.

NATIONAL AIROIL BURNER Company, Incorporated

1254 EAST SEDGLEY AVENUE, PHILADELPHIA 34, PENNA.

OIL BURNERS • GAS BURNERS • GAS PILOTS • PUMP SETS • EXPLOSION DOORS
ACCESS DOORS • AIR DOORS • BURNER BLOCKS • FURNACE OBSERVATION WINDOWS

KOVEN *for* REFINERY *and* PETRO-CHEMICAL EQUIPMENT

Until victory is ours, KOVEN engineers will continue to give their knowledge and experience in the refinery and petro-chemical field to aiding the war effort. When victory has been won KOVEN engineers will be ready to aid these rapidly growing industries in their post-war expansion.

KOVEN has been designing and manufacturing chemical equipment for over 50 years. They have no patented process to sell and all equipment is made to order in the KOVEN plants. The facilities of these two huge plants are capable of handling equipment of any size.

A KOVEN expert will be glad to work with you in designing equipment to solve your specific problem. A consultation does not obligate you in any way. Simply call or write KOVEN today.

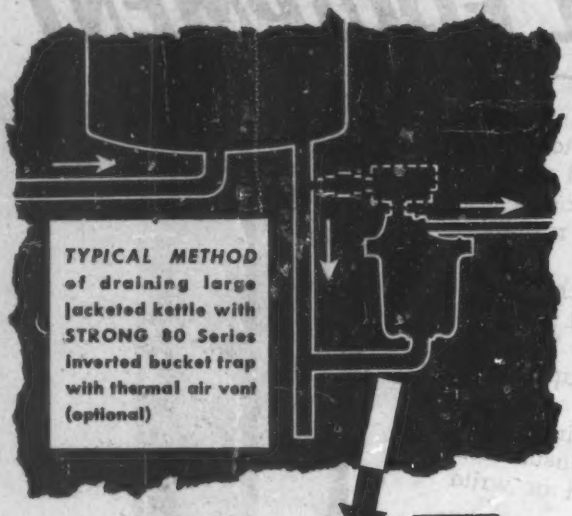
Among the many pieces of KOVEN equipment are: pressure vessels, extractors, mixers, stills, condensers, kettles, tanks, containers, stacks, coils. ASME & A.P.I. code welding.

L. O. KOVEN & BRO., INC.
154 OGDEN AVENUE • JERSEY CITY 7, N. J.

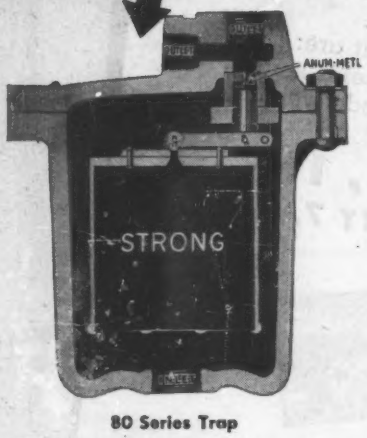
PLANTS: JERSEY CITY, N. J. DOVER, N. J.

TRAP it RIGHT!

SPEED production...SAVE steam


TYPICAL METHOD
of draining large jacketed kettle with STRONG 80 Series inverted bucket trap with thermal air vent (optional)

ANSWERS by the people who build the *most complete* line of traps



80 Series Trap

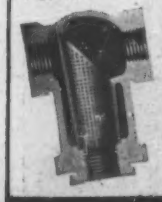
Strong inverted bucket traps are superior for draining steam kettles, unit heaters, dry kilns, and heat exchangers. They handle large quantities of air and condensate. Turbulence during discharge helps pass scale or dirt. Strong's patented anti-balancing device assures full intermittent discharge even at low rates of condensation.

★ ★ ★

Completeness of the Strong line enables us to recommend exactly the type and size you need—open or inverted bucket, closed float, float-and-thermostatic (blast), etc.—forged, welded, cast and semi-steel construction. Send your problems to Strong, Carlisle & Hammond Co., Cleveland, Ohio.

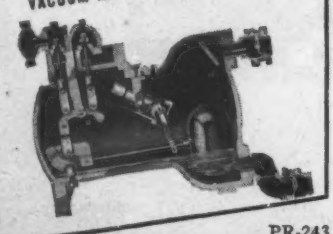
OTHER STRONG STEAM SPECIALTIES

STRAINERS



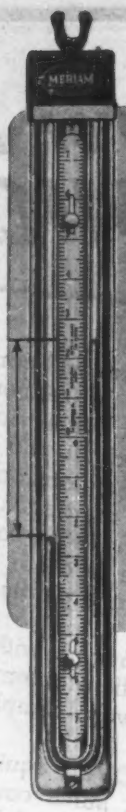
REDUCING VALVES

VACUUM AND LIFTING TRAPS



PR-243

STRONG
STEAM SPECIALTIES



MERIAM Clean-Out MANOMETER

QUICKLY AND EASILY
CLEANED WITHOUT DISCONNECTING

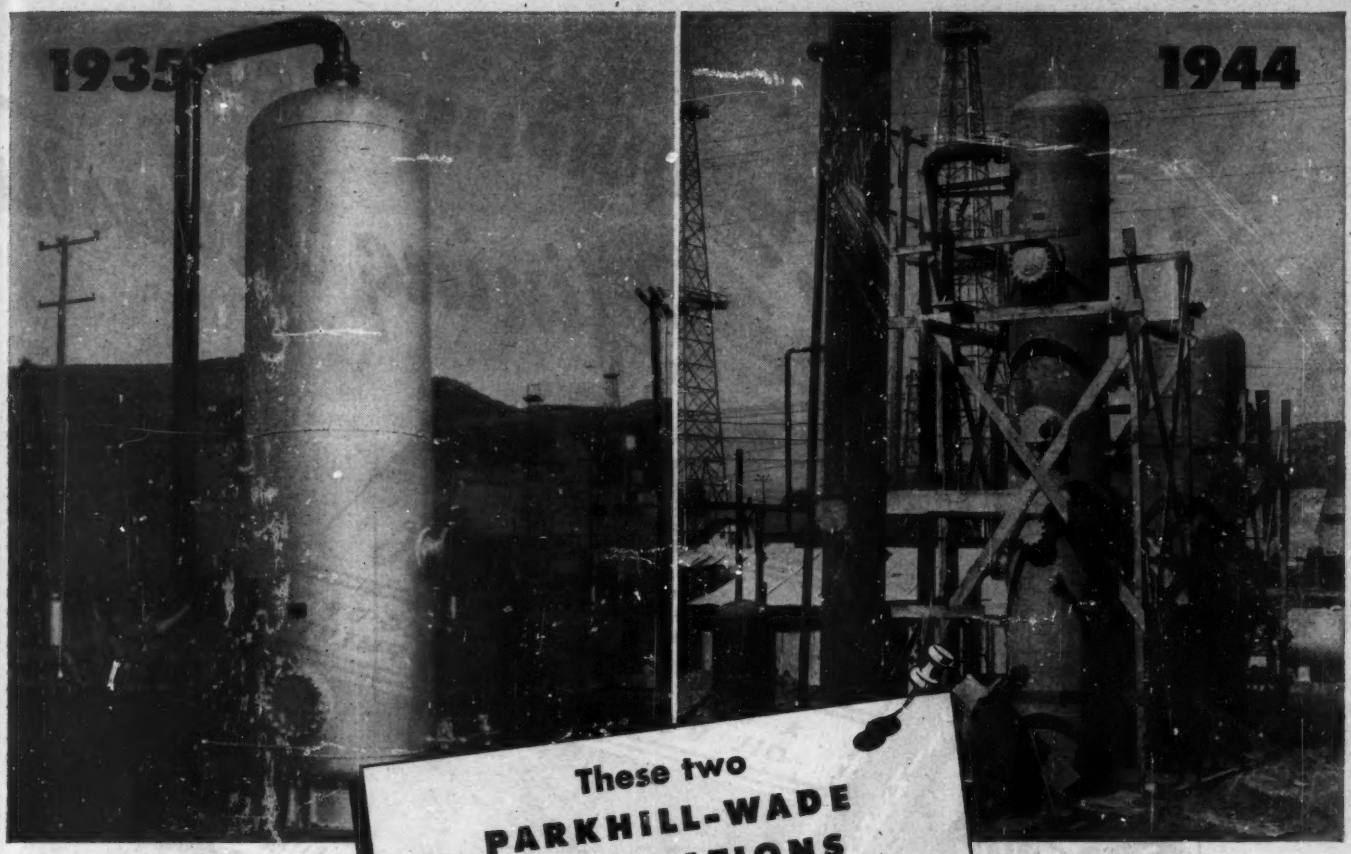
This U-Type Clean-Out Manometer is for checking gas and air pressures from a few ounces up to several pounds. Suitable for either portable service or permanent installation.

The head is quickly removed—with a few turns of the wing nut—permitting quick cleaning of tube, with brush furnished. This feature also adds to its portability. It also allows convenient changing of the indicating fluid (oil, water or mercury).

This Clean-Out Manometer is available in standard ranges from 6" to 50". One of many instruments made by us throughout the past 32 years. Ask for Bulletin 1.

THE MERIAM INSTRUMENT COMPANY
10966 Madison Avenue • Cleveland 2, Ohio

MERIAM ★ *Instruments*
★ ESTABLISHED 1911
MANOMETERS, METERS AND GAUGES FOR THE ACCURATE MEASUREMENT OF PRESSURES, VACUUMS AND FLOWS OF LIQUIDS AND GASES



Original Calcium Chloride Dehydration Plant designed and constructed by Parkhill-Wade in 1935 for one of the large California utilities. The most advanced gas dehydrator of its type at that time.

These two PARKHILL-WADE INSTALLATIONS represent 9 years' improvement in gas dehydration!

New Diethylene Glycol Dehydration Plant just completed by Parkhill-Wade for the same company, in the same field. Circuit and process use latest developments available in gas dehydrating technique.

IN 1935, the calcium chloride dehydration unit shown at left above was designed and built by Parkhill-Wade and installed for one of the largest gas companies in California. The second unit of its kind in the United States, *it represented at that time the most advanced development in gas dehydration technique!*

But at right is the new Diethylene Glycol Dehydration Plant just completed by Parkhill-Wade for the *same* company—in the *same* field—and installed next to the original brine unit. Constructed to handle 50,000,000 cubic feet of gas per day at 400 pounds pressure, this new plant is the very *latest* advancement in dehydrating operations, incorporating many important new features. Conversion to diethylene glycol called only for an additional contactor, diethylene glycol rectifier, heat exchanger and control equipment.

▶ *The process and circuit used—the result of Henry N. Wade's developments in gas dehydration—provide greatly improved results over the original calcium chloride . . . in higher water removing efficiency . . . elimination of corrosion . . . lowering of dewpoint . . . and simplification of equipment needs.*

This is only one example of Parkhill-Wade engineering ability in gas processing. Before you install *any* gas handling equipment, it will pay you to investigate the many outstanding Parkhill-Wade developments in gas plant and pipeline design. Our engineering staff will be glad to provide you with further details on these advancements.

Parkhill-Wade engineers and designs equipment of all kinds for large-scale processing of the lighter hydrocarbons. We will be glad to make recommendations—or work with you toward solution of special engineering problems. Write—briefly outlining your requirements.

Parkhill and Wade — *Parkhill-Wade*

THE UNIVERSAL EQUIPMENT CODE of the Refining Industry

THE UNIVERSAL EQUIPMENT CODE OF THE REFINING INDUSTRY . . . THE REFINERY CATALOG . . . is a time-saver for busy engineers and executives because a given page number and a given figure number is the same to key men in refineries everywhere.

No lengthy descriptions on expensive long distance calls to get a meeting of the minds. No reference to folders which the man at the other end of the wire can't find quickly.

SAVE TIME and avoid mistakes by referring immediately to the universal equipment code of the refining industry . . . THE REFINERY CATALOG.

THE REFINERY CATALOG

A Gulf Publishing Company Publication . . . 3301 Buffalo Dr., P. O. Box 2608, Houston, Texas

CATALOGS BULLETINS

Helpful Publications Which Manufacturers Will Be Glad to Send Free for the Asking

USE THIS COUPON

.....
MANUFACTURER'S NAME

.....
MANUFACTURER'S ADDRESS

Please send me, without obligation, free booklet described in December, 1944 issue of PETROLEUM REFINER.

NAME.....

ADDRESS.....

Filters

Oliver United Filters, Inc., 33 West 42nd Street, New York 18, is distributing Bulletin 405-R on filters for refiners.

Chemical Pumps

Milton Roy Pumps, 1300 East Mermaid Avenue, Philadelphia 18, is distributing Catalog No. 941, on chemical pumps and proportioners, which describes pumps for practically every chemical service.

Welding

Galv-Weld Products, 395 East Second Street, Dayton 10, Ohio, has available data on welding galvanized sheet, plate and pipe.

Dry-Material Cooler

Fuller Company, Catasauqua, Pennsylvania, is distributing Bulletin PMC-1, illustrating and describing the Fuller Dry Pulverized-Material Cooler.

Welding-Cable Connections

Tweco Products Company, English at Ida, Wichita 7, Kansas, has issued a 16-page catalog which describes a complete line of cable connections for electric welding.

Fluxes

Superior Flux Company, 913 Public Square Building, Cleveland, Ohio, is distributing a new catalog which describes a line of 20 fluxes for welding, brazing, silver soldering, soft soldering and low-temperature alloy welding of ferrous and non-ferrous metals and alloys.

Laboratory Equipment

Schaar & Company, 750 West Lexington Street, Chicago 7, has issued a 320-page catalog of laboratory equipment, featuring a complete listing of laboratory glassware and porcelain and smaller pieces of apparatus used in the modern laboratory, and a selection of larger pieces of equipment.

Stainless-Steel Welding

Page Steel and Wire Division of American Chain & Cable Company, Monessen, Pennsylvania, has issued a new informative book on Page-Allegheny stainless-steel welding electrodes, which in addition to suggestions on selection of electrodes for welding stainless steel, includes information on welding procedures.

Flashlight Battery

The B. F. Goodrich Company, Industrial Products Division, Akron, Ohio, is distributing a six-page catalog section on its recently introduced rechargeable wet storage battery for flashlights. The catalog section outlines the development of the rechargeable wet storage battery built on the same principle as the automobile storage battery. Much of the space is given to text and illustrations of the charging units which the company sells in connection with the battery.

Flow Meter

Cochrane Corporation, 17th and Allegheny Avenue, Philadelphia 32, is distributing publication 3010-31 on the Cochrane Tilting U-Tube Mechanical Meter. Three fundamental features are incorporated in this high-torque mechanical meter: flow measurement by response to difference in pressure by a mercury seal in a U-Tube; weighing mass by means of a beam balance, and the use of torsion tubes as the scientific solution of the stuffing-box problem. Exceptionally high operating torque and therefore high accuracy over long life is claimed.

Instruments

Leeds & Northrup Company, 4934 Stenton Avenue, Philadelphia 44, is distributing its Folder ENT (7a), a 28-page general catalog issue of "Modern Precision," which describes all L&N products for regulating plant processes. One section describes instruments for measuring by each of four pyrometric methods; thermocouple, rayotube, thermohm, and optical. For other plant processes, equipment which measures such quantities as pH, speed, gas analysis, etc., are described, with installation photographs showing the equipment in service. Another section is devoted to laboratory instruments.

V-Belt Handbook

The B. F. Goodrich Company, Akron, Ohio, is distributing a 74-page V-Belt Handbook for Industrial Applications which it believes contains the greatest amount of data ever assembled in a similar volume. The handbook discusses the operating advantages of V-belts, qualities to seek in the product, installation and care, sheaves, selection of the V-belt drive, and general information covering the whole field. Data includes tables on installation and take-up allowances, listing of five cross sections and complete variety of V-belt lengths, service factors, general belt-selection table, combination-groove or standard cast-iron drives, stock drives, standard drives, V-flat drivers, quarter-turn drives, sheaves, belt speeds, horsepower ratings of multi-V-belts, corrections for arc of contact and exact speed of driven machine, standard groove dimensions for industrial V-belt sheaves, together with sheave dimension tables.

Welded-Seam Test Method

Kano Laboratories, 75 East Wacker Drive, Chicago 1, has available literature on use of its "Kano Kroil," a creeping, penetrating chemical for testing tightness of welded seams in tanks without use of pressure.

Anhydrous Ammonia

The Barrett Division, Allied Chemical & Dye Corporation, 40 Rector Street, New York 6, is distributing an informative illustrated booklet describing the physical and chemical properties and some of the principal uses of anhydrous ammonia.

Tachometers

Jones Motrola Company, Fairfield Avenue, Stamford, Connecticut, is distributing Bulletin No. 44-1, which describes four models of Jones individual-mount tachometers and the Jones multi-range portable hand tachometer.

Step-Valve Pumps

Milton Roy Pumps, 1300 East Mermaid Avenue, Philadelphia 18, is distributing Bulletin 4311, descriptive of Milton Roy Step-Valve Pumps with electronic volume control. A system of motor-speed control is used to regulate the volume of liquid pumped by a chemical or high-pressure pump.

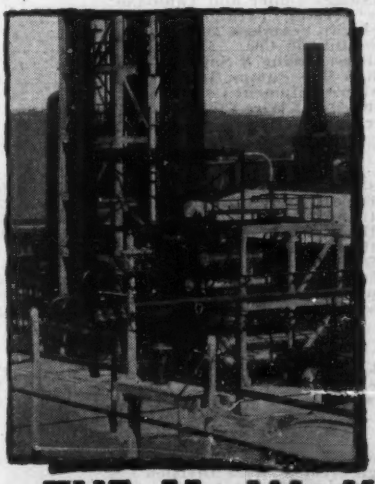
Insulate and Rust-Inhibit

AT THE SAME TIME WITH

THERMOSTIC No. 2

KELLOGG

Shipped in the form of dry cement Thermostic No. 2 mixes readily with water to form a smooth working; light weight and economical rust inhibited insulation for monolithic construction on stills, tanks, heat exchangers, towers, furnace walls, etc.



Users find this rust inhibited light weight insulation has a greater coverage capacity than average insulation and is unusually adhesive to hot or cold surfaces.

Thermostic No. 2 will not deteriorate and can be reclaimed for use again if temperatures have been maintained below 1200°F.

A test will prove its money-saving value to you.

THE M. W. KELLOGG COMPANY

Sales Office: 225 Broadway, New York 7, N. Y. Plant: Jersey City, N. J.

Representatives in CHICAGO • DETROIT • PITTSBURGH • LOS ANGELES

INDEX TO ADVERTISERS *in this Issue of* PETROLEUM REFINER

A

Acadia Synthetic Products Division Western Felt Works ... 74
*Alco Products Division American Locomotive Co. ... 52-53
*Alcorn Combustion Co. ... 202
*The Aldrich Pump Co. ... 22
Aluminum Company of America ... 31
*The American Brass Co. ... 279
American Cyanamid & Chemical Corp. ... 212
*American District Steam Co. ... 252
*American-Marsh Pumps, Inc. ... 45
*American Meter Co. ... 7
American Optical Co. ... 32
American Pipe & Construction Co. ... 222
American Steel & Wire Co. ... 61
*The V. D. Anderson Co. ... 254
Apex Iron & Metal Co. ... 282
*Armstrong Cork Co. ... 175
*Armstrong Machine Works ... 5
*Associated Piping & Engineering Co. ... 174
*Automatic Sprinkler Corporation of America ... 188
Avondale Marine Ways, Inc. ... 64

B

*The Babcock & Wilcox Co. ... 56
*The Babcock & Wilcox Tube Co. ... 273
*Bakoring Incorporated ... 204
*Baldwin-Hill Co. ... 180
*M. L. Bayard & Co. ... 10
*Bethlehem Supply Co. ... 181
W. H. & L. D. Betz ... 216
*Blaw-Knox Co. ... 21
Bonney Forge & Tool Works ... 269
*Born Engineering Co. ... 280
Bridgeport Brass Co. ... 34
*The Bristol Co. ... 162-163
*The Brown Fintube Co. ... 224
*The Brown Instrument Co. ... 42
*Byron Jackson Co. ... 43

C

*Calapor Manufacturing Co. ... 265
Calumet & Hecla Consolidated Copper Co. ... 250
The Carborundum Co. ... 225
Cardox Corp. ... Insert, opposite 49
Carnegie-Illinois Steel Co. ... 61
*The Carpenter Steel Co. ... 38
The Chapman Valve Manufacturing Co. ... 226
Chase Brass & Copper Co. ... 47
*Chemical Construction Corp. ... 51
*Chicago Bridge & Iron Co. ... 190-191
*Clark Bros. Co. ... Insert, opposite 176
*Climax Molybdenum Co. ... 271
*Cochrane Corp. ... 274
Columbia Steel Co. ... 61
*The Cooper-Bessemer Corp. ... 142-143
*Coppus Engineering Corp. ... 153
The Corbett Corp. ... 167
*Crane Co. ... 6
*Croll-Reynolds Engineering Co. ... 264

D

Dallas Tank Co. ... 252
*Darling Valve & Manufacturing Co. ... 9
*Dayton-Dowd Co. ... 79
*Dean Brothers Pumps, Inc. ... 266
*M. H. Detrick Co. ... 213
*The Dow Chemical Co. ... 76 and 78
*Dravo Corp. ... 272
Dresser Industries, Inc. ... 168-169
E. I. du Pont de Nemours & Co. ... 189
*The Duraloy Co. ... 30

E

The Edward Valve & Manufacturing Co. ... Insert, 144-145
Electro Metallurgical Co. ... 15
*Elliott Co. ... 137 and 228
*Ellsworth Pipe & Supply Co. ... 50
*Engineers & Fabricators, Inc. ... 197

F

*Filtrol Corp. ... 219
Fischbach & Moore of Texas ... 176
*Fischer & Porter Co. ... 193
The Flori Pipe Co. ... 71
*Floridin Co. ... 211
The Fluor Corp. ... 157
*Foster Wheeler Corp. ... 146-147
*The Foxboro Co. ... 35 and 215
*Franklin Supply Co. ... 185

G

*The Garlock Packing Co. ... 30
*General American Process Equipment Division General American Transportation Corp. ... 287
*General American Transportation Corp. ... 253
General Chemical Co. ... 151
*General Electric Co. ... 28-29
*The Girdler Corp. ... 195
Fritz W. Glitsch & Sons ... 229
*Globe Steel Tubes Co. ... 179
Graham Manufacturing Co. ... 54
*Grinnell Co. ... 158
*The Griscom-Russell Co. ... 33
Gulf Engineering Co. ... 280
Gunite Concrete & Construction Co. ... 280

H

D. W. Haering & Co. ... 278
Hanlon-Buchanan, Inc. ... I Cover
*Hanlon-Waters, Inc. ... 57
The Harshaw Chemical Co. ... 230
Haynes Stellite Co. ... 55
*S. D. Hicks & Son Co. ... 278
*Hills-McCanna Co. ... 260
*Homestead Valve Manufacturing Co. ... 232
*Hooker Electrochemical Co. ... 260
Houdry Process Corp. ... 59
Hudson Engineering Corp. ... 201
Humble Oil & Refining Co. ... 236
Hycar Chemical Co. ... 16

I

*Industrial Insulators, Inc. ... 280
*Ingersoll-Rand ... 154-155
The International Nickel Co. ... 44 and 246

J

*Jerguson Gage & Valve Co. ... 178
*Johns-Manville ... 40 and 214

K

Keasbey & Mattison Co. ... 58
*The M. W. Kellogg Co. ... 217, 231 and 285
The Kennedy Valve Manufacturing Co. ... 237
*Kerotest Manufacturing Co. ... 239
Walter Kidde & Co. ... 281
*Kieley & Mueller, Inc. ... 234
*Maurice A. Knight ... 170
*L. O. Koven & Bro., Inc. ... 267

L

Ladish Drop Forge Co. ... Opposite 48
Layne & Bowler, Inc. ... 276
*Leeds & Northrup Co. ... 8
*Leyman Manufacturing Corp. ... 62
*Lilie-Hoffmann Cooling Towers, Inc. ... 254
The Liquidometer Corp. ... 70
*The Lummus Co. ... Insert 16-17 and 238

M

*M. & B. & M. Pipe Fabricating Co. ... 164
*Madsen Iron Works ... 192
*The Marley Co. ... 23
*Mason-Neilan Regulator Co. ... 2-3
The Master Electric Co. ... 243
The Mathieson Alkali Works, Inc. ... 73
The Maxim Silencer Co. ... 17
*A. Y. McDonald Manufacturing Co. ... IV Cover
*The John H. McGowan Co. Division Leyman Manufacturing Corp. ... 62
*Arthur G. McKee & Co. ... 141 and 282
*McNamar Boiler and Tank Co. ... 282
*The Meriam Instrument Co. ... 268
Michigan Seamless Tube Co. ... 63
The Midvale Co. ... 241
*Midwest Piping & Supply Co. ... 75
*Milton Roy Pumps, Inc. ... 264
*Mixing Equipment Co. ... 24-25
*Multi-Metal Wire Cloth Co. ... 272
*Murray Iron Works Co. ... 74

N

*Nash Engineering Co. ... 263
*National Airoil Burner Co. ... 266
*National Carbon Co. ... 277
*National Foam System, Inc. ... 240
National Tube Co. ... 19
Nelson Specialty Welding Equipment Corp. ... 39
*Newark Wire Cloth Co. ... 156
*Newman, Hender & Co. ... 26

O

Oakite Products, Inc. ... 274
*The Ohio Steel Foundry Co. ... 12-13
*Owens-Corning Fiberglas Corp. ... 60

P

*Pacific Pumps, Inc. ... 14
Page Steel & Wire Division American Chain & Cable Co. ... 242
*The Palmer Co. ... 152
Parkhill-Wade, Inc. ... 283
*The Patterson Foundry & Machine Co. ... 183
*The Patterson-Kelley Co. ... 259
*Penberthy Injector Co. ... 135
*Petro-Chem Development Co. ... 207
*Petroleum Engineering, Inc. ... 198-199
*Petroleum Rectifying Co. ... 261
Philadelphia Gear Works ... 49
The Pioneer Rubber Co. ... 211
*Pittsburgh-Des Moines Steel Co. ... 36
Plant Rubber & Asbestos Works ... 187
*Plibrico Jointless Firebrick Co. ... 72
Porocel Corp. ... 20
*H. K. Porter Co. ... 80
The Wm. Powell Co. ... 245
*The Pressed Steel Co. ... 258
Presstite Engineering Co. ... 255
*%Proportioneers, Inc.% ... 288

Q

The Quaker Oats Co. ... 148

R

*R-S Products Corp. ... 150
Reading-Pratt & Cady Division American Chain & Cable Co. ... 46
*Reed Roller Bit Co. ... 247
Reinhold Publishing Co. ... 182
Republic Steel Corp. ... 257
*The Ridge Tool Co. ... 18
The Roto Co. ... 184
*The Ruberoid Co. ... 244

S

*Schutte & Koerting Co. ... 27
Scovill Manufacturing Co. ... 161
Shand & Jurs Co. ... 68
Shell Development Co. ... 256
A. O. Smith Corp. ... 11
Smith Meter Co. ... 233
Smooth-On Manufacturing Co. ... 282
Solvay Sales Corp. ... 235
*Southwest Welding & Manufacturing Co. ... 275
*Stratford Engineering Corp. ... 205
*Strong, Carlisle & Hammond Co. ... 268
*Sun Shipbuilding & Dry Dock Co. ... 223

T

*Taylor Forge & Pipe Works ... 66
*Taylor Instrument Companies ... 172-173
Texaco Developemnt Corp. ... 48
*Texas Pipe Bending Co. ... 41
Thomas Flexible Coupling Co. ... 196
The Timken Roller Bearing Co. ... 4
*Tube-Turns, Inc. ... 139
*Tulsa Boiler & Machinery Co. ... 220

U

*Union Asbestos & Rubber Co. ... Insert, opposite 177
Union Carbide and Carbon Corp. ... 15, 55 and 277
United States Steel Corp. ... 19 and 61
*Universal Oil Products Co. ... 203

V

*The Vapor Recovery Systems Co. ... 248
Vinson Supply Co. ... 251
*Henry Vogt Machine Co. ... 218
*Volcanic Specialties Co. ... 282
*Vulcan Steel Tank Corp. ... 26

W

*John Waldron Corp. ... 211
*Wallace & Tiernan Products, Inc. ... 200
Walworth Co. ... 240
*The Watson-Stillman Co. ... 227
*The Webster Engineering Co. ... 210
Western Felt Works ... 74
Westinghouse Electric & Manufacturing Co. ... 171
Westvaco Chlorine Products Corp. ... 37
*The Whitlock Manufacturing Co. ... 70
A. R. Wilfley & Sons Co. ... 221
*Thomas C. Wilson, Inc. ... 206
Wolverine Tube Division Calumet & Hecla Consolidated Copper Co. ... 250
*Worthington Pump & Machinery Corp. ... 65, 67 and 69
Wyatt Metal & Boiler Works ... III Cover

Y

*Yarnall-Waring Co. ... II Cover and 204

Z

*Zallea Brothers & Johnson ... 208

***Detailed Information on Advertiser's Products or Services in 1943 Edition of The Refinery Catalog**

A Solvent Dewaxing Filter

designed by engineers experienced in clarification filtration

Specially designed and constructed throughout for the clarification filtration of oil-solvent mixtures at low temperature, the Conkey Solvent Dewaxing Filter design provides for dependability with new standards of operating efficiency and economy.

Incorporated in its distinctive design and construction, are features which have demonstrated their effectiveness and economy over years of operation.

Some of these features are—totally enclosed operation—long cloth life and ease of redressing—positive separation of wash and filtrate—elimination of residual filtrate blow-back into wax cake on reverse blow for scraper discharge.

Conkey Solvent Dewaxing Filters are fabricated in the Plate and Welding Division shops at Sharon, Pennsylvania which have been continuously serving the refinery industry for over half a century. They are available in standard drum sizes for nominal filter areas of 50 to 500 square feet.

Write for bulletin.

★ ★ ★ ★ ★ ★ ★ ★ ★

GENERAL AMERICAN PROCESS EQUIPMENT DIVISION GATX GENERAL AMERICAN

General American Process Equipment is a consolidation of four outstanding process equipment manufacturers, each a well-known specialist in its field, now welded together to serve you with one organization, one responsibility and one high standard of performance.

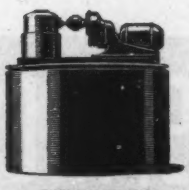
This organization also represents the Plate and Welding Division of General American Transportation Corp., at Sharon, Pa.

GENERAL AMERICAN PROCESS EQUIPMENT

A Division of General American Transportation Corporation

Executive Offices: 439 BAXTER AVENUE, LOUISVILLE 4, KENTUCKY
New York Office: 420 LEXINGTON AVENUE, NEW YORK 17

FRACTIONATING COLUMNS, PRESSURE VESSELS

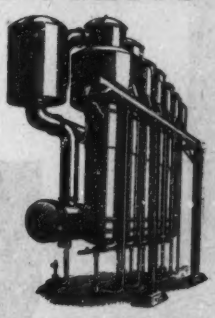


TURBO-MIXERS, AGITATORS, AERATORS

CONKEY VACUUM AND PRESSURE FILTERS

AMERICAN DRUM DRYERS AND FLAKERS

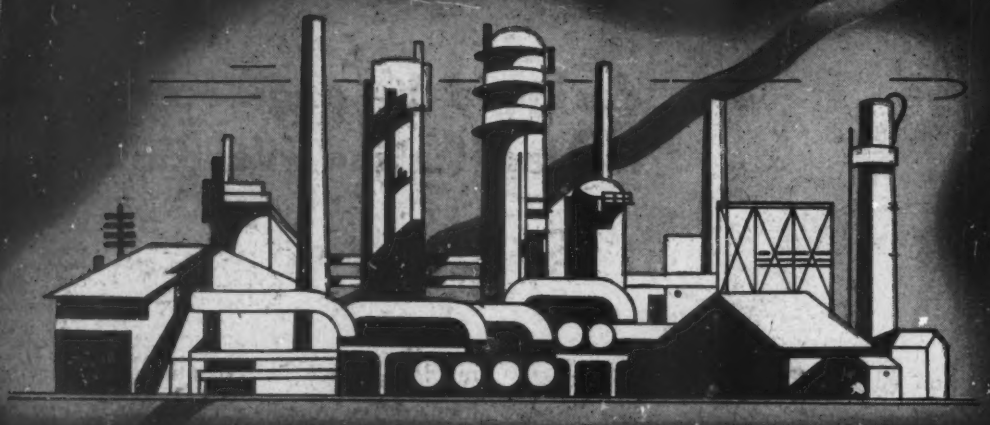
LOUISVILLE DRYERS, COOLERS, KILNS



CONKEY VACUUM EVAPORATORS

%PROPORTIONEERS, INC.%

Continuous



PROCESSING AND BLENDING
EQUIPMENT
FOR THE REFINERY INDUSTRY

ACID TREATING	GASOLINE BLENDING	PROCESS TREATING
ASPHALT BLENDING	GUM INHIBITING	SAMPLING
BOILER WATER TREATING	LEAD BLENDING	SPECIAL EQUIPMENT
CONTINUOUS DYEING	LUBE OIL BLENDING	WATER CONDITIONING

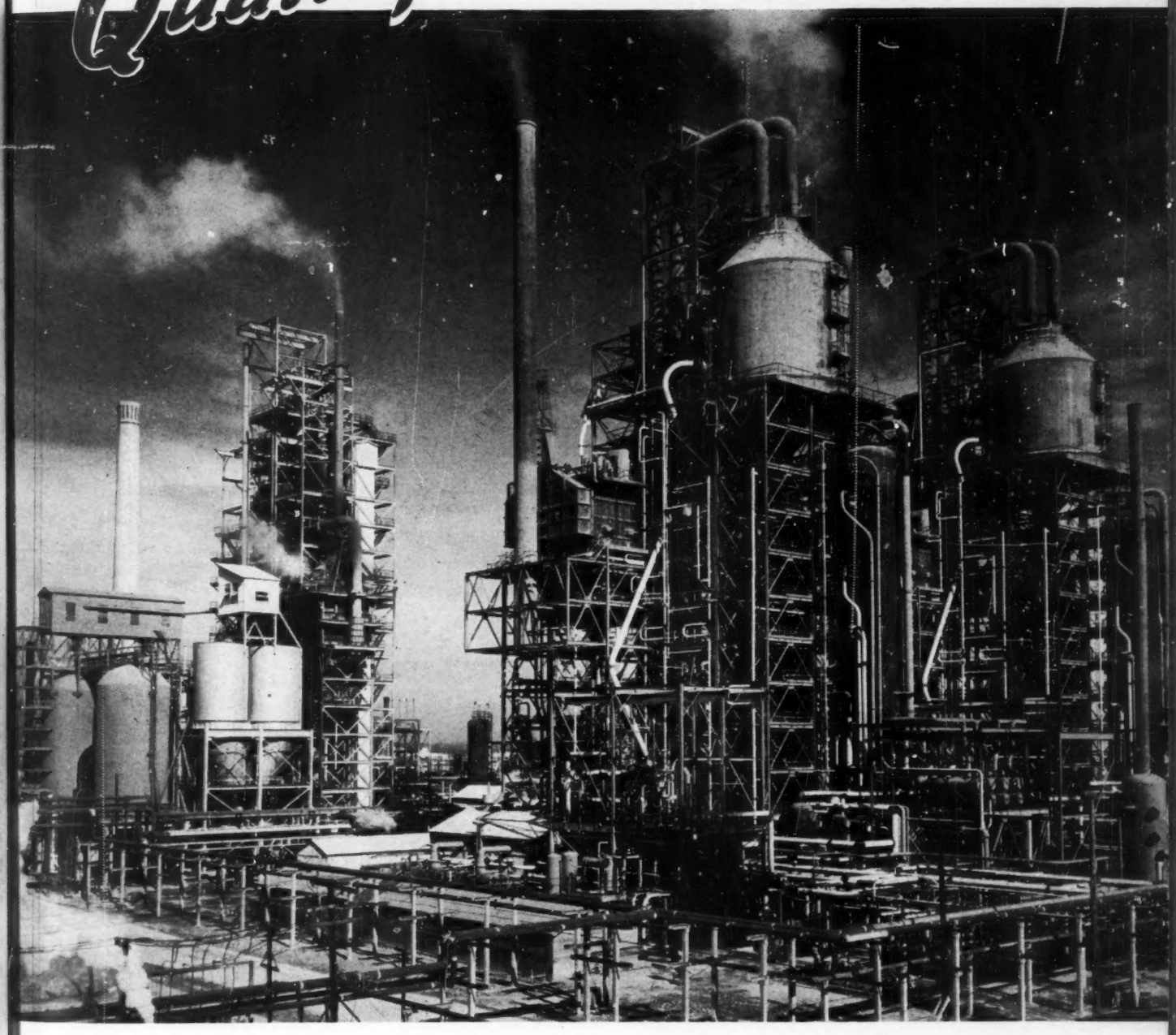
%Proportioneers, Inc.%, specialists in the field of proportioning equipment, offer up-to-the minute engineering advice and the latest equipment—flow responsive or constant rate—for CONTINUOUS processing and blending.

Send for Bulletin 1700

%PROPORTIONEERS, INC.%

WRITE TO %PROPORTIONEERS, INC.%, 31 CODDING STREET, PROVIDENCE 1, RHODE ISLAND

Quality



Quality is responsible for Wyatt fabricated products being used in 123 of the 191 plants now making fighting fuel to help win this war.

Wyatt's

Emergency Valves

FOR STORAGE TANKS

PLATE 970-H (Valve Open)

PLATE 970 (Valve Closed)

NOTE: Except for hold-open device supplied with Plate 970-H, both valves are identical.

POSITIVE PROTECTION FOR A VITAL COMMODITY

• This is definitely not just another emergency valve. It is a carefully engineered, precision built McDonald product that provides positive protection for the contents of your tanks in emergencies but does not retard their movement under normal conditions.

FULL FLOW. For attaching to the tank, the 2" size has a 2½" male thread and the 3" size a 4" male thread to assure full 2" and 3" flow respectively (the 2" size may, however, be ordered with a 2" male thread if desired, to accommodate 2" flange opening of tanks already in service).

EXTRA-LARGE PORT OPENINGS. Position and size assure full opening despite the fact that inside flanges may be used.

NO DISTORTION OF SEAT. Even where the tank flange is improperly tapped, or excessive force is used in attaching the valve, the seat is protected against distortion by its distance from the threads.

LONG THREADS. Accommodate off-size of flange tapping; allow for re-tapping of flange threads.

POSITIVE ACTION. In Plate 970-H a fusible link is incorporated into the hold-open device. Plate 970 may be operated by means of a cable with one or more fusible links. In either instance closing is assured, in case of fire near the tank, by the use of a spring designed extra long and extra large to avoid overstressing.

Available in 2" x 2", 2" x 2½", 3" x 3" and 3" x 4" sizes—and definitely worth investigating.

A. Y. McDONALD MFG. CO.

"THE HOME OF THE SWING JOINT"

DUBUQUE, IOWA

There's a McDonald Branch or Distributor Near You

McDONALD